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BIOPHYSICAL INVENTORY, SIGNIFICANT, SENSITIVE AND DISTURBANCE FEATURES OF THE WHALEBACK AREA

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Purpose of Study 1
1.2 Study Area Location 2

2.0 STUDY AREA DESCRIPTION 4
2.1 History and Land Use 4
2.2 Climate 5
2.3 Topography and Drainage 7
2.4 Bedrock Geology 8
2.5 Surficial Geology 9
2.6 Soils 9
2.7 Vegetation 10
2.8 Fauna 12

3.0 METHODS 15
3.1 Preliminary Interpretation 15
3.2 Field Data Collection 15
3.3 Ecological Land Classification Methods 16
3.4 Data Analysis 17
3.5 Significant Features Mapping 17
3.6 Slope Class Mapping 19
3.7 Sensitive Features Mapping 19
3.8 Disturbance Features Mapping 20
3.9 Polygon Database Preparation 20

4.0 RESULTS 23
4.1 Ecological Land Classification Mapping 23
4.2 Description of Vegetation Community Types 23
4.3 Significant Features 42
4.3.1 Significant Flora 42
4.3.2 Significant Fauna 43
4.3.2.1 Avifauna 45
4.3.2.2 Mammals 53
4.3.2.3 Herptiles 69
4.3.2.4 Fish 69
4.3.3 Checklists of Significant Areas 73
4.4 Slope Class Mapping 81
4.5 Sensitive Features 81
4.6 Disturbance Features 87

5.0 DATA GAPS 89

6.0 GENERAL OBSERVATIONS OF THE STUDY AREA 92

7.0 LITERATURE CITED 94

APPENDIX A: FROST DESIGN CLASSIFICATION
APPENDIX B: ROCKINESS CLASSES
APPENDIX C: SURFACE STONINESS CLASSES
APPENDIX D: SHRINK-SWELL POTENTIAL
APPENDIX E: SIGNIFICANT FLORA OF THE WHALEBACK STUDY AREA
APPENDIX F: FAUNAL SPECIES ANTICIPATED TO OCCUR IN THE WHALEBACK STUDY AREA
APPENDIX G: PHOTOGRAPHS OF REPRESENTATIVE FEATURES
APPENDIX H: WHALEBACK AREA ECOLOGICAL LAND CLASSIFICATION LEGEND, Part 1 and Part 2

List of Figures

Figure 1: Location of the Whaleback study area 3
Map 2: Whaleback Significant Features 74

List of Tables

Table 1: Ecogeographic Distribution of Expected Resident Wildlife Species in the Whaleback Study Area 13

Table 2: Elk Population Trend Counts for WMUs Encompassing the Whaleback Study Area 56

Table 3: Preferred Forage Items Of Ungulates on Sub-alpine and Foothill Ranges in Alberta 58

Table 4: Moose Densities Reported From Various Areas of North America 59

Table 5: Sensitivity classes related to ELC units for the Whaleback study area 83

1.0 INTRODUCTION

1.1 Project Purpose and Objectives

The term "biophysical inventory" was coined in order to connote the blending of several fields of natural resource science as a way of describing terrestrial ecosystems (Lacate 1969). Under this approach, the terrestrial ecosystem is referred to in a holistic manner as being composed of a complex web of abiotic and biotic ecological components including geomorphology, bedrock geology, soils, vegetation, and wildlife.

The biophysical resource information presented in this study is structured to form the basis for the integration of land-use planning with ecologically sound resource conservation practices so as to support resource and range management initiatives within the area.

The purpose of the project was to conduct a biophysical land classification inventory and identify and map significant ecological features, disturbance features and sensitive features. As well, established range vegetation community types were used as components of biophysical map units to supply additional range inventory data. The specific objectives of the study were as follows:

1. To conduct a biophysical inventory at the ecosite hierarchical level within the Whaleback study area at a scale of 1:20 000.

2. To identify and describe range and forest vegetation community types at field observation sites and to integrate these types in the biophysical classification and mapping process. The biophysical mapping units will be designed to reflect habitat requirements of key wildlife species and will include wildlife suitability ratings for each unit. Identification of established range vegetation community types as biophysical map unit components will be used to extend range inventory information across the study area.

3. To provide digitized ARC/INFO .E00 format biophysical maps and legends for the study area at a scale of 1:20 000.

4. To identify and map significant ecological features, disturbance features and sensitive features in the Whaleback study at a mapping scale of 1:20 000.

5. To provide digitized ARC/INFO .E00 format thematic maps of special features including significant ecological features, disturbance features and sensitive features at a mapping scale of 1:20 000.

6. To utilize Digital Elevation Model (DEM) data to produce a sufficiently detailed, digital topographic ARC/INFO .E00 format map layer showing slope or slope/aspect categories in order to delineate areas suitable for range and/or wildlife habitat improvement.

7. To provide reconnaissance level information on the presence, relative abundance, and location of significant avifauna and other wildlife species in the study area and;

8. To provide a summary report for the study area.

1.2 Study Area Location

The Whaleback study area is situated within the Montane and Sub-Alpine Subregions of the Rocky Mountain Natural Region in the southwestern corner of Alberta (Alberta Environmental Protection 1994).

The study area encompasses approximately 4.5 townships (approximately 260 km^2). The study area includes portions of Township 10 - Ranges 2 and 3, Township 11 - Ranges 2 and 3, Township 12 - Ranges 2 and 3, and Township 13 - Ranges 2 and 3, all West of the Fifth Meridian (Figure 1). The study area is approximately 110 km south of the City of Calgary, 40 km west of the town of Claresholm, 40 km northwest of the town of Pincher Creek, and 20 km northeast of the Municipality of Crowsnest Pass. Western portions of the study area located in the Rocky Mountains Forest Reserve, approximately 20 km east of the Alberta - British Columbia border. Much of the eastern boundary of the study area follows a 500 KV power transmission line (Kolar and Brawn 1986) located along the eastern flank of Whaleback Ridge. Highway 22, an increasingly traveled route between Calgary and southeastern British Columbia falls outside the eastern boundary of the study area. The western boundary of the study area parallels the segment of the Forestry Trunk Road (Secondary Road 940) linking Kananaskis Country and the Crowsnest Pass. The Upper Bob Creek Ecological Reserve is located near the centre of the study area at Township 12, Range 2, W5M.

FIGURE 1 : LOCATION OF THE WHALEBACK STUDY AREA

2.0 STUDY AREA DESCRIPTION

2.1 History and Land Use

The foothills and Porcupine Hills were located on periphery of the Blackfoot and Peigan plains tribes' ancestral territory. In addition a well-traveled route of the Kootenay, Stoney, and Flathead peoples followed the broad valley separating the Porcupine Hills and the Rocky Mountain Foothills on the eastern edge of the study area (Kolar and Brawn 1986). The Peigan and Blackfoot people obtained tipi-poles, and hunted buffalo (*Bison bison*) wintering in the foothills (Kolar and Brawn 1986). The large herds of buffalo grazing the foothills rough fescue (*Festuca scabrella*) ranges of the Porcupine Hills were important to the Peigan and Blackfoot people. They utilized sandstone cliffs in steep coulees as jumps to kill large numbers of animals in the fall, when animals in prime condition were entering the foothills from the plains (Malouf and Conner 1962). The seasonal movement of buffalo from the plains into the foothills was witnessed by two early European explorers to this region, Peter Fidler in 1772, and Captain George Palliser in 1859 (Duffy 1971).

The extirpation of the buffalo in the foothills occurred circa 1880 (Duffy 1971), shortly after the Blackfoot Indians signed Treaty No. 7 in 1877. The cattle ranching industry soon discovered the attributes of the foothills that had made them attractive to the wintering buffalo - shallow winter snowpacks maintained by mild winds called chinooks, and highly productive fescue pasture (Lupton 1967). The cattle herd sizes grew rapidly in 1880s and 1890s on large unfenced grazing leases in the foothills, resulting in severe overgrazing of the range during this period (Kelly 1913; Kolar and Brawn 1986). Also at this time the demand for lumber increased with the influx of people engaged various activities including coal mining, wolf hunting, law enforcement and ranching, resulting in several lumbering operations in the foothills and Porcupine Hills (Duffy 1971).

Cattle ranching has been the dominant land-use in the Whaleback area since the 1880s. This industry has progressed from an extreme overstocking of ranges with cattle in the late 19th century, to a sustainable situation of reduced herd sizes, and rotational grazing systems (Nowicki 1973).

Forest operations are restricted to the Subalpine Natural Region portion of the study area with timber harvesting occurring in the Livingstone River valley and along the slopes of the Livingstone Range. The Montane Natural Subregion portion of the study area does not support forestry activities at this time.

Approximately 80 percent of the study area is public land under grazing lease, while the remainder is titled land used for cattle grazing and limited hay production. The study area predominantly consists of native prairie utilized for cattle production, and to a lesser extent, subalpine forest utilized by the forestry industry. Cultivation is essentially absent from the study area except for hay

fields on ranches in the Oldman River, along Bob Creek south of the Ecological Reserve, and Callum Creek valleys. Petroleum development is concentrated in the Savanna Creek field (Township 14, Range 5) south of Plateau Mountain, directly north of the study area, and Grassy Mountain (Township 9, Ranges 3 and 4) immediately southwest. An oil and natural gas pipeline parallels the Forestry Trunk Road while another parallels Highway 22. Geophysical exploration of this portion of the Rocky Mountains and adjacent foothills is evident through several seismic lines which bisect parts of the study area. A 500 KV power transmission line (Kolar and Brawn 1986) is located along the eastern flank of Whaleback Ridge for its entire length, forming the eastern boundary of the study area. Coal mining was a major industry until the 1980s, with both underground and strip mines operating immediately southwest of the study area. Approximately 1600 megatonnes of coal remain within the Rocky Mountains between the Livingstone Range and the British Columbia border (Alberta Energy and Natural Resources 1987).

The Upper Bob Creek Ecological Reserve, in Township 12, Range 2, West of the Fifth Meridian, occupies 24.6 km^2 of the study area and is surrounded by public land zoned for "Multiple Use" and "Critical Wildlife" (Alberta Energy and Natural Resources 1987).

2.2 Climate

The climate of the foothills of southwestern Alberta is characterized by short, cool, moist summers and cold dry winters, with high evaporation rates as a result of strong winds and low humidity. The foothills provide a unique "biological-climatological" environment due to their elevation above the Great Plains and their position in the lee of the Rocky Mountains. The combination of these factors produce mild winters and high early-summer precipitation (Duffy 1970). The Whaleback Study Area is situated in the Rocky Mountain Natural Region (Alberta Environmental Protection 1994a). The study area straddles two subregions found within the Rocky Mountain Natural Region, specifically, the Montane and the Sub-Alpine natural subregions. The Montane Natural Subregion has a climate that is warmer than other subregions found along the foothills of Alberta. This subregion is characterized by chinooks which keep the area intermittently snow-free in the winter (Archibald et al. 1996). The Sub-Alpine Natural Subregion has greater winter precipitation than any other part of Alberta, although this figure varies greatly due to mesoclimatic changes even within the subalpine portion of the study area.

No climate stations are located within the study area. The most representative climate station relative to the Whaleback Study Area, in terms of location and elevation, is located at the E.P. Ranch (Pekisko), approximately 32 km north of the study area at an elevation of 1439 meters above sea level (masl) (Environment Canada 1993). This compares favourably to the elevation of the study area which ranges from 1300 m in the lower valleys to 2100 m at the mountain summits, and to its position relative to the mountain front, i.e. 10 km east. Pekisko climate station is located

within the Montane Natural Subregion, close to its boundary with the Foothills Parkland Natural Subregion.

Precipitation, in the form of rain, is concentrated in the growing season (381.7 mm), which is indicative of a continental climate (Duffy 1971). The greatest portion (185.1 mm) falls during May and June. The mean annual precipitation at Pekisko is 683 mm. In contrast, Calgary and Lethbridge, located on the plains, have 398.8 mm and 386.5 mm of annual precipitation respectively. Only 28 percent (191 mm) of the precipitation occurs from November to March. Upslope weather conditions and cyclonic storms in April, May and June produce heavy snowfall and rainfall which account for 38 percent (260 mm) of the annual precipitation. Summer precipitation is somewhat lighter 196 mm (28% of total), and occurs in the form of thundershowers produced by cyclonic convergence along the Rocky Mountains (Borchert 1950). Measurable precipitation occurs on between 10 and 12 days per month during summer and decreases to 6 to 9 days in winter. Snowfall (November - March) is 190.2 cm with an additional 130 cm occurring as spring and fall wet snowfalls. Snow depths are variable and generally shallow during winter, though no data is available for the study area. Days of continuous snow cover are few.

The mean annual temperature is 2.1°C. Calgary and Lethbridge, by contrast, have an average annual temperature of 3.9°C and 5.4°C respectively. July and August are the warmest months at Pekisko, with a mean temperature of 12.9°C between the two months and an average daily maximum temperature of 21°C. The summer average temperatures in the foothills comprising the study area are approximately 4°C lower due to elevation (300 - 500 m higher) than the plains to the east. The frost-free growing season is correspondingly shorter at foothills locations with Pekisko having only 858 growing degree-days compared with plains locations such as Claresholm with 1418 growing degree-days. December and January are the coldest months with an average temperature of -8.9°C and an average daily minimum temperature of -15.6°C. Recorded extreme temperatures range from a maximum of 36.1°C, to a minimum of -46.7° C. Prevailing winds are from the west and average approximately 15 - 25 km/hr (Thomas 1953 in thesis). Wind speeds in SW Alberta generally average 16 - 25 km/ hour (Thomas 1953). Chinooks, which occur approximately 30 times from October to April (Longley 1967), account for the strongest winds which often reach velocities of 110 km/hr (Shouesmith 1972).

Climate data for the Montane Natural Subregion shows an average annual precipitation of 440 mm, with approximately 59 percent of this (259 mm) occurring during May through September (Strong 1992). June and August are the wettest months. Average annual temperature is 3.5°C, with a monthly mean of -6.6°C in January and an average daily mean temperature of 12.1°C from June - August. Mean growing degree days above 5 °C for the ecoregion are 946. Coleman, located in the Crowsnest Pass 40 km southwest of the study area at an elevation of 1341 masl. is also representative of the Montane Natural Subregion portion of the study area with an average annual temperature of 3.5°C, a monthly mean of -8.3° C in January and an average daily mean temperature of 13.5°C from June - August. Growing degree days are 1147. Summer precipitation

at Coleman is only 69% of that received at Pekisko, suggesting that the study area has a wetter summer climate than the portions of the Montane Natural Subregion located in the low east-west mountain passes that comprise the majority of the Montane Natural Subregion locations in Alberta (Strong 1992) .

The Subalpine Natural Subregion has a cooler summer climate than that of the Montane Natural Subregion. The daily mean summer (June-August) temperature for the Livingstone Fire Lookout, formerly located at 2170 m within the western portion of the study area, but since removed, is 10.0°C (Environment Canada 1993). This value is 1.9°C less than that recorded at Pekisko, 730 m lower in elevation. The summer precipitation recorded at the Livingstone Fire Lookout of 167.6 mm is only 71% of Pekisko.

2.3 Topography and Drainage

The study area falls entirely within the Oldman River basin, providing a large proportion of water to the South Saskatchewan River which eventually drains into Hudson Bay via the Saskatchewan and Nelson Rivers. A minor drainage divide bisects the study area; the northern portion drains via Willow Creek while the southern and western portions drain via the Oldman River. A trellis drainage pattern dominates the area, caused by linear foothill and mountain ridges (Alberta Energy and Natural Resources 1987).

The topography of the area can be characterized as being controlled by underlying bedrock, with veneers of glacial moraine and glaciofluvial outwash terraces from these glacial advances producing only relatively minor changes in relief in the landscape (Alberta Energy and Natural Resources 1987).

Elevation of the Whaleback study area ranges from approximately 1250 m above sea level (masl) in the southeastern corner of the study area at the Oldman River, to approximately 2170 masl on the crest of the Livingstone Range. Average elevations of foothill ridges, of which the dominant is the Whaleback Ridge, range from 1600 masl in the eastern part of the study area to 1800 masl in the western portion adjacent to the Livingstone Range. The intervening valleys such as Bob and Camp Creek have an elevation of approximately 1300-1400 masl.

Physiography of the area largely reflects the underlying rock lithologies and geologic structure. Due to their thickness and resistance to erosion, Paleozoic strata form the highest areas of relief such as the High Rock Range of the Continental Divide and the Livingstone Range, while Mezosoic sandstones form the lower ridges such as the Whaleback Ridge, and argillaceous shales underlie valleys (Alberta Energy and Natural Resources 1987). Because of glacial, lacustrine, or alluvial deposition, valley floors in the foothills are wide and characteristically flat-

bottomed. Only the larger streams, such as the Oldman and Livingstone Rivers are incised into bedrock.

Surface expression is variable in the study area. The glaciofluvial outwash terraces in the Oldman River floodplain on the south edge of the study area are overlain by deposits of alluvium. The Oldman River, west of The Oldman Gap, and the Livingstone River are bounded by floodplains with gently undulating to rolling surfaces. The main north-south trending foothill ridges have strongly rolling and ridged topography, with undulating and floodplain topography predominating in the valleys. The Livingstone Range and outlying upper foothills have steeply inclined topography (Alberta Energy and Natural Resources 1987).

2.4 Bedrock Geology

The Whaleback Study Area is located within the Rocky Mountain Foothills and Rocky Mountain Physiographic Regions (Pettapiece 1986) and is underlain by tightly folded and faulted Mesozoic sedimentary bedrock with long fold axes typical of the foothills (Alberta Energy and Natural Resources 1987) and overthrusted sheets of older Paleozoic sedimentary rock typical of the Front Ranges of the Rocky Mountains (Alley 1972).

The bedrock formations of the Rocky Mountain Foothills Physiographic Region are described from the lowest, most easterly to the highest, most westerly strata. The Upper Cretaceous non-marine sedimentary bedrock of the Belly River Formation, comprised of grey-green siltstone, sandstone, and carbonaceous shale, underlies moraine veneers and blankets in the valleys which separate the linear foothill ridges in the eastern portion of the study area (Jackson 1981). Upper Cretaceous marine interbedded sandstone and shale of the Alberta Group underlies these ridges, periodically outcropping at locations such as Black Mountain and Whaleback Ridge. Linear foothills ridges follow faults visible where sandstone bedrock is close to the surface and reduces the vigor of grassland vegetation. Willow Creek and Mill Creek Faults are the main foothills faults in the study area, both located on the eastern flank of Whaleback Ridge.

The higher foothills in the western portion of the study area, adjacent to the eastern side of the Livingstone Range, have a non-linear configuration, unlike the linear ridges such as Whaleback Ridge. These higher foothills are underlain by continental and marine grey to greenish grey sandstones and shales of the Blairmore Group.

The Rocky Mountain Physiographic Region is represented by the Livingstone Formation, an overthrust of marine, light-grey Rundle Group, Paleozoic limestone. The Livingstone Range rises approximately 800 m above the Oldman River valley at the point where it forms an impressive water gap, known as "The Gap" through that range.

2.5 Surficial Geology

The study area was glaciated by Laurentide and Cordilleran ice sheets during the Pleistocene epoch. Subsequent ice meltdown deposited extensive veneers of till over the bedrock ridges, while meltwater from retreating ice lobes deposited extensive river outwash terraces.

Laurentide and Cordilleran ice sheets alternately covered the area during the Pleistocene epoch. Laurentide ice advanced at least three times westwards to the base of the Livingstone Range during the Pincher advance, Porcupine advance and the Furman advance (Stalker 1953, 1962). Canadian Shield erratics, indicating approximate continental ice thickness, have been found up to 1600 m on the east side of Whaleback Ridge (Alley 1972). Cordilleran ice advanced several times during the Pleistocene epoch, with glacier flows from Crowsnest Pass and Oldman Gap being trapped against the Porcupine Hills during the "Alberta advance" of the Laurentide ice sheet (Wagner 1966). Large meltwater lakes were formed between these converging ice lobes, depositing clays and silts in the valleys of the study area (Wagner 1966). These deposits were overridden by moraine and glacial outwash from subsequent continental advances and retreats, producing the complex stratigraphy characteristic of the southern foothills. During maximal continental ice thicknesses, such as during the "Alberta advance", only those peaks east of the continental divide above 2130 m protruded as nunataks above the ice. Glaciers in the Livingstone River valley flowed southwest across the Continental Divide via Crowsnest and Deadman Passes during the "Alberta advance" (Wagner 1966). Throughout the Pleistocene epoch, periodic ice advances blocked main drainage courses, such as the Oldman River and Willow Creek. Stratigraphy of the southern foothills indicates that three main cordilleran advances, and three continental ice advances occurred, each causing extensive glacial lakes to form (Alley 1972). The largest advance of continental ice into the foothills - The Maunsell - prevented meltwater from the retreating mountain glaciers in the Livingstone river valley from flowing east, thus forming glacial Lake Oldman and Glacial Lake Westrup, joined by a channel directly east of the Whaleback Ridge. This lake attained a maximum elevation of 1372 masl, depositing silt in the existing Oldman River and Callum Creek valleys. Streams entering the lake, such as the Oldman River, and Chaffen Creek on the south and north edges of the study area formed extensive deltas (Alley 1972). Varved clays and silts, indicative of seasonal fluctuations in lake levels, are well preserved within till stratigraphy in the southern foothills (Stalker 1953).

2.6 Soils

Factors which influence the development of soil include climate, biota, relief and parent material, all acting over time. As well, landform is a major controlling influence on soil development by its modification of the effects of regional climate through variations in slope, aspect and drainage, with subsequent effect on soil development processes such as additions, subtractions,

translocations and transformations of parent material by physical and biological agents (Brierley et al. 1989, Pawluk et al. 1966).

Parent materials on ridges in this area of southwestern Alberta are often strongly calcareous, with a marked decrease in soil development on steep southern aspects (Shouesmith 1972). Soils within the study area itself are largely formed on veneers (depths of from 10 cm to one meter) and blankets (material extending to depths greater than one meter, but underlying bedrock topography still discernible) of colluvial, morainal, residual, fluvial, glaciofluvial and glaciolacustrine parent materials overlying bedrock. As such, soils of the study area are typically shallow on upland areas, with consolidated bedrock found from a few centimeters to a meter or two below the ground surface.

Predominant soils within the study area are Eluviated and Orthic Eutric Brunisols in forested areas and Orthic Black and Rego Black Chernozems in grassland areas. Textures are variable, with textures in upland areas often dependent on the composition of underlying bedrock strata from which the overlying parent material is usually derived, such as siltstones and shales of the ridges bordering the Camp Creek valley and sandstones comprising much of Whaleback Ridge, for example, and textures in other areas generally dependent on the type and origin of surficial deposits within which the soils have formed.

Soils within some forested areas can also be Chernozemic, exhibiting evidence that these soils developed under grassland vegetation, and include Orthic Black, Eluviated Black, and Dark Gray Chernozems. Dark Gray Luvisols, with possible inclusions of Orthic Gray Luvisols, can occur to a significant extent in some forested areas.

Humic Gleysols can be found on poorly drained sites. Orthic and Cumulic Regosols can be found in riparian areas, and other Regosolic soils are common in colluvial areas. Organic soils often occur as veneers and blankets over mineral soil in wetland areas.

Specific soils are summarized further within the Ecological Land Classification legend accompanying Map 1.

2.7 Vegetation

Native vegetation of the Whaleback study area is highly variable, encompassing communities typical of Montane and Sub-Alpine natural regions, as well as communities transitional between them. The influence of regional climate and local climate is reflected in the vegetation, with extensive grasslands interspersed with deciduous and coniferous forests at lower elevations, and subalpine grassland and coniferous forest at higher elevations (Alberta Energy and Natural Resources 1987). Within the drier, southern portion of the study area, tree and extensive shrub

growth is only able to occur in moist, sheltered locations at lower elevations, such as spring-fed coulees, hillside seeps, and riparian areas.

The actual community and species representation at any given site will be influenced by numerous factors, including elevation and its effect on annual precipitation, as well as microsite variability in terms of aspect, slope, moisture regime and drainage, other soil properties, and wild and domestic livestock grazing intensity. Winter snowcover is an extremely important factor in the distribution of forest and grassland communities (Breitung 1954). Chinook winds rapidly melt and redistribute snow cover from exposed slopes, (i.e. those with an aspect from west to south), to sheltered north and east aspects, producing deep snowpacks in those areas. This uneven distribution of snow has a pronounced effect on moisture and vegetation distribution by creating areas of strongly negative moisture balances on exposed slopes, and slightly positive moisture balances in sheltered locations such as north and north-east facing slopes and at higher elevations (Breitung 1954). Moisture deficits occur at lower elevations and on south and west-facing slopes at higher elevations, promoting the distribution of grasslands. This moisture deficit is severe on south-facing slopes and particularly on southwest-facing slopes which are exposed to warm and dry prevailing winds. Conversely, positive moisture balance allows for forest growth on north and northeast-facing slopes at lower elevations.

Prevalent grass species within the study area include rough fescue (*Festuca scabrella*), Parry oat grass (*Danthonia parryi*), California oat grass (*Danthonia californica*), June grass (*Koeleria macrantha*), slender wheat grass (*Agropyron trachycaulum*), northern wheat grass (*Agropyron dasystachyum*), Richardson needle grass (*Stipa richardsonii*), pine reed grass (*Calamagrostis rubescens*) and hairy wild rye (*Elymus innovatus*). Grassland communities are predominantly rough fescue-dominated. Species dominance changes in response to factors such as grazing intensity, elevation, moisture regime and amount of brush and forest encroachment. Rough fescue is a highly productive grass species which provides highly valuable winter forage. It is a decreaser which declines relatively quickly under prolonged heavy grazing pressure during the growing season (Coupland and Brayshaw 1953).

Prevalent tree species in forest communities in the study area include aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), and white spruce (*Picea glauca*). Limber pine (*Pinus flexilis*) is restricted to exposed ridgetops and sandstone bedrock outcrops in the study area. Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) are found at high elevations in the Livingstone Range. Whitebark pine (*Pinus albicaulis*) is an occasional species found at high elevations at grassland - forest ecotones along Horseshoe Ridge, Chaffen Ridge and other similar sites in the Livingstone Range.

Detailed discussion of the vegetation of the study area is presented in Section 4.2 of this report.

2.8 Fauna

Of the complex web of factors which influence wildlife species distribution and abundance in a given region, vegetation communities are the most critical. Since vegetation cover is actually an expression of a variety of biophysical conditions such as soil, aspect, and relief, it generally offers a current prediction of habitat suitability for most wildlife species. As has been described previously in this section, the Whaleback study area is located in montane and sub-alpine environments characterized by a complex system of ridges, leeward slopes, and active floodplains. As a result, vegetation cover ranges from riparian willow shrublands at lower elevation valley bottoms through to extensive coniferous and mixedwood forests of pine, spruce, fir, and poplar throughout much of the study area. Apart from the forested communities, open grassland communities are prevalent on south-facing slopes where a combination of moisture, slope, soil, and climatic conditions has deterred the encroachment of trees.

This diversity and interspersion of vegetation types provides habitat for a variety of wildlife species. Recent field work in the study area and investigations into geographical ranges of birds (from Semenchuk 1992), mammals (from Smith 1993), and herptiles (from Russell and Bauer 1993) indicate that the Whaleback study area may provide habitat for as many as 150 bird species, 57 mammal species, two reptile species, and four amphibian species (see Appendix F). The general lack of wetland and other aquatic habitats in the Whaleback study area is reflected in the expected species assemblage, as a distinct paucity of water-dependent wildlife is evident, particulary in the case of amphibians and waterbirds such as shorebirds, waterfowl, and gulls.

Among the resident fauna, terrestrial vertebrates from numerous guilds are predominant, as a variety of large carnivores, ungulates, small fossorial mammals, microtines, chiropterids, passerines, diurnal and nocturnal raptors, and woodpeckers can be found in the area. While many significant and/or sensitive wildlife species inhabit the Whaleback study area, perhaps the most significant use of the Whaleback is by elk (*Cervus elaphus*). The Whaleback study area is regarded as encompassing one of the two most significant elk wintering ranges in the province and has been widely recognized as provincially significant for this reason by numerous previous researchers (Bradley et al. 1977, Wallis 1980, Kolar and Brawn 1986, Brown et al. 1986, Cottonwood Consultants Ltd. 1987, Fairbarns 1989, O'Leary et al. 1989, AEP 1995). The value of the Whaleback region and its significance to both regional and provincial elk populations is further elucidated in Section 4.3.2.2.

In addition to the provision of elk winter range, the Whaleback study area provides habitat for a significant number of species which occur at the limits of their range in Alberta or in western Canada. Based on the ecogeographic classification originally described by Hagmeier and Stults (1964), numerous representative species of Cordilleran and Boreal-Cordilleran faunal elements occur in the vicinity of the Whaleback study area. Wildlife species of the Cordilleran faunal element are essentially those which have distributions centering on the Rocky Mountains and

include such animals as pika (*Ochotona princeps*), Clark's nutcracker (*Nucifraga columbiana*), and American dipper (*Cinclus mexicanus*). These species are essentially mountain species; they are more common in the rugged terrain to the west of the Whaleback study area but have also been documented in the Whaleback. Smith (1993) identified 15 Alberta mammal species which are members of the Cordilleran faunal element and it is anticipated that 12 of these species may occur on the periphery of their range in the Whaleback study area.

Wildlife species of the Boreal-Cordilleran faunal element are those which occupy a broad range across the boreal forest with southward extensions along both the western and eastern North American mountain ranges. Species such as northern bog lemming (*Synaptomys borealis*), snowshoe hare (*Lepus americanus*), northern flying squirrel (*Glaucomys sabrinus*), and willow flycatcher (*Empidonax trailii*) are typical of this faunal element and occur at latitudes as far south as the Whaleback only in the projections along the mountain chains. Of the 18 Alberta mammal species comprising this faunal element (Smith 1993), all except one - the fisher (*Martes pennanti*) - occur in varying levels of abundance in the Whaleback study area.

Still other wildlife species are widespread, having ranges that are so extensive that a common center cannot be identified. As can be expected by definition, most of the species found in the Whaleback study area fit this "widespread" category, as species such as common yellowthroat (*Geothlypis trichas*), northern flicker (*Colaptes auratus*), little brown bat (*Myotis lucifugus*), and beaver (*Castor canadensis*) are found in appropriate habitats throughout most of Alberta (Table 1).

Table 1: Ecogeographic Distribution of Expected Resident Wildlife Species in the Whaleback Study Area

SPECIES GROUP	# OF SPECIES	FAUNAL ELEMENT					
		Widespread	Cordilleran	Boreal-Cordilleran	Great Basin	Campestrian	Eastern Forest
Mammals	57	23	12	17	4	1	-
Birds	102 [1]	53	19	13	5	6	3
Amphibians	4	1	1	1	-	1	-
Reptiles	2	2	-	-	-	-	-

1. Includes three (3) introduced, non-native species - wild turkey (*Meleagris gallopavo*), rock dove (*Columba livia*), and European starling (*Sturnus vulgaris*).

As the above table shows, the majority of wildlife species in the Whaleback study area are either widespread or have affinities to Cordilleran or Boreal-Cordilleran elements. However, an

additional five mammals (long-eared bat [*Myotis evotis*], long-legged bat [*Myotis volans*], Richardson's ground squirrel [*Spermophilus richardsoni*], northern pocket gopher *[Thomomys talpoides*], and sagebrush vole [*Lagurus curtatus*]), 14 birds (Cooper's hawk [*Accipiter cooperii*], northern goshawk [*Accipiter gentilis*], Swainson's hawk [*Buteo swainsoni*], golden eagle [*Aquila chrysaetos*], prairie falcon [*Falco mexicanus*], upland sandpiper [*Bartramia longicaudus*], mourning dove [*Zenaida macroura*], horned lark [*Eremophila alpestris*], northern rough-winged swallow [*Stelgidopteryx serripennis*], rock wren [*Salpinctes absoletus*], mountain bluebird [*Sialia currucoides*], western meadowlark [*Sturnella neglecta*], northern oriole [*Icterus galbula*], and American goldfinch [*Carduelis tristis*]), and one amphibian (tiger salamander [*Ambystoma tigrinum*]) have distributional affinities to southern grassland or eastern hardwood habitats, yet range into appropriate grassland or deciduous habitats within the Whaleback study area.

The above ecogeographic analysis clearly shows that the location of the Whaleback study area is such that allows the overlap of numerous faunal elements, ranging from grassland adapted species of the Great Basin faunal element to alpine adapted species of the Cordilleran faunal element, as well as a few more faunal elements that are transitional between the two. The resultant diversity of wildlife species present in the study area is one of the keys to its significance in the province. In addition, the Whaleback study area is noted for: (a) its provincially significant elk winter range; (b) provincially significant moose (*Alces alces*) habitat; (c) one of the highest recorded densities of cougar (*Felis concolor*) in Alberta; and (d) the provision of nesting habitat for naturally scarce raptors such as golden eagle (*Aquila chrysaetos*) and prairie falcon (*Falco mexicanus*). The relatively intact and pristine wilderness nature of much of the Whaleback study area further accentuates the importance of the area to resident wildlife species, many of which have been documented to require large tracts of undisturbed wildlands. Section 4.3.2 provides more details regarding the significant fauna and faunal guilds that are found in the Whaleback study area.

3.0 METHODS

3.1 Preliminary Interpretation

A series of 1:20,000 black and white panchromatic aerial photographs dated September 10, 1991 and September 5 and 7, 1987, were used for preliminary ecological land classification (ELC) mapping and to identify vegetation physiognomic types, special features and disturbance features. Preliminary interpretation of ELC polygons was adapted to also consider the ecological significance of ELC units primarily for wildlife habitat and secondarily on the function of the units for primary, secondary or non-use range areas. As well, previous ecological land classifications (Alberta Energy and Natural Resources 1979, O'Leary et al. 1989) and physical land classifications (Leskiw 1993) were considered during the definition of ELC units.

Three primary sources of information were obtained that assisted in the identification of vegetation community types. These included *Range plant community types and carrying capacity for the Subalpine Subregions. First approximation* (Willoughby and Smith 1996), *Range plant community types and carrying capacity for the Montane Subregion (Montane Ecoregion). Second approximation* (Willoughby *et al.* 1996) and *Field guide to ecosites of southwestern Alberta* (Archibald *et al.* 1996). Where possible, vegetation community types identified during the course of this study correspond to the types defined in these sources.

Digital Elevation Modeling data was used to produce a slope class map for the study area, as discussed in more detail in Section 3.6.

An extensive literature review was also undertaken to determine special features previously identified in the study area and in adjacent areas.

3.2 Field Data Collection

Field sampling was conducted in two ten day shifts, from July 22 to August 1 and August 6 to 15, 1996 according to methods outlined in the *Ecological Land Survey Site Description Manual* (Alberta Environmental Protection 1994b). Initially, potential field sample sites were selected by using aerial photographs. Site locations were chosen to document the range of vegetation community types and biophysical map units throughout the area. Plot selection was additionally based on the ecological significance of sites for wildlife habitat and for range use, and to fill in data "gaps" between existing range management or biophysical surveys. Recent field sampling was done within the Upper Bob Creek Ecological Reserve during previous studies (Leskiw 1993, Downing and Karpuk 1994), therefore no sampling was done in the ecological reserve during the course of the present study.

All-terrain vehicle (ATV), helicopter and foot access were utilized. At each site, information was collected on soils, parent materials, vegetation composition and site characteristics, using standard field plot forms. Vegetation survey methodology for forest and shrub communities followed that of the Ecological Land Survey Site Description Manual (Alberta Environmental Protection, 1994) using form LISD 14B. For grassland, methodology was based on that described by Alberta Forest Service (1990) and Robertson and Adams (1990). Within grasslands, an average of seven to eight 0.5 m^2 microplots were completed to establish a pattern of species dominance with data summarized on Vegetation Inventory form (MF5). Since this inventory was not intended as a range survey, coupled with the amount of information already collected on rangeland and the time constraints of the survey, it was decided, in consultation with Mike Alexander (Range Forester, Bow/Crow Forest) that fewer than the standard ten microplots would suffice. This data was then summarized for keypunching to conform to form LISD 14B. Plant taxonomy follows Moss (1983) with common names conforming to Alberta Environmental Protection (1993).

One soil pit was described at each sample site. Site observations, including parameters such as topography, slope, aspect, ecological moisture regime and nutrient regime among others, were also recorded at each sample site. Soil and site survey methodology followed guidelines outlined by Alberta Environmental Protection (1994b). Photographs were taken at each site to illustrate physiographic and physiognomic characteristics.

A total of 100 detailed field inspection sites were established. Due to time constraints few reconnaissance sites were inspected. Livestock use observations were recorded at each site.

Reconnaissance-level wildlife information was also gathered as part of the biophysical inventory. Wildlife observations were recorded through incidental observations made during transit between intensive study sites. Wildlife observations were also made during reconnaissance traverses for this purpose, conducted in the study area between September 9 through 11, 1996. Notations and site-specific observations were recorded as deemed necessary for all wildlife observations.

3.3 Ecological Land Classification Methods

Ecological Land Classification (ELC) is a hierarchical landscape mapping system in which the land surface is subdivided and classified into areas of similar environments. The map units are characterized by recurring patterns of surficial materials, landform, soil and vegetation.

The primary method used to derive ecological units is aerial photo interpretation. The land surface is delineated according to factors such as slope, landform, drainage, parent materials and vegetation. After background data compilation and the initial interpretation, field checks are

carried out to verify descriptions of the map units and to compile more detailed site, soil and vegetation information.

To classify and map ELC units, the landscape is generally divided into a four-tiered hierarchical system based on dominant landscape characteristics - Natural Subregion, Ecodistrict, Ecosection and Ecosite. The basic unit used for mapping in this study was the Ecosite level at a mapping scale of 1:20 000. Final cartography was completed at a scale of 1:20 000. The higher levels of classification were considered in the initial interpretation but omitted from the final mapping.

Each ecosite unit was given a descriptive map unit symbol. For example, for the ecosite symbol GF1.2, GF describes the primary landform, in this case glaciofluvial, while the following numeric character, 1, describes a subdivision based on physiographic features, in this case, terrace. The last numeric character, 2, distinguishes each subdivision on the basis of vegetation physiognomic type, for example, closed coniferous forest, mixed wood forest or grassland.

3.4 Data Analysis

Vegetation community classification for the Whaleback Study Area was not done quantitatively on the basis of plant species dominance in the community as determined by statistical methods. To do so would imply a level of sampling intensity which allowed for species dominance to be determined and mapped throughout the study area. This sampling intensity did not exist for this study. Vegetation community types were thus defined on the basis of landscape features and physiognomic characteristics mappable from aerial photography. Parameters used for the classification included general species dominance (percent canopy cover), slope, aspect, ecological moisture regime, nutrient regime, parent material, soil texture, topographic position, drainage and salinity. Vegetation patterns arising from the above parameters were identified and are described in this report. Where possible, vegetation community types identified during the course of this study correspond to the types defined in Archibald *et al.* (1996), Willoughby *et al.* (1996) and Willoughby and Smith (1996).

3.5 Significant Features Mapping

The identification of significant features, particularly of rare flora and fauna, relied heavily on review of existing information as project and time constraints precluded the undertaking of intensive surveys specifically designed to identify populations in the field. The significance of sites within the Whaleback study area was based on a consideration of 12 criteria as outlined by Eagles (1984), including:

- areas which perform a vital environmental, ecological or hydrological function such as aquifer recharge
- areas which contain rare or unique geological or physiographic features
- areas which contain significant, rare or endangered plant or animal species
- areas which are unique habitats with limited representation in the region or are a small remnant of once large habitats which have virtually disappeared
- areas which contain an unusual diversity of plant and/or animal communities due to a variety of geomorphological features and microclimatic effects
- areas which contain large and relatively undisturbed habitats and provide sheltered habitat or species which are intolerant of human disturbance
- areas which provide an important linking function and permit the movement of wildlife over considerable distances, including migration corridors and migratory stopover points
- areas which contain plants, animals or landforms which are unusual or are of local, regional, provincial, national or international significance
- areas that are excellent representatives of one or more ecosystems, habitats or landscapes
- areas with intrinsic appeal due to widespread community interest or the presence of highly valued features or wildlife species valued for hunting
- areas which perform a vital function for wildlife in the area
- areas with cultural, historical or archaeological significance.

The significance of each site was categorized according to Eagles (1984) as follows:

International - features which are unique in the world

National - features which are limited in distribution at a national level or which are the best or only representatives in Canada

Provincial - features which are of limited distribution or are the best examples of a feature in the province

Regional - features which are of limited distribution or are the best examples of a feature in the region

Local - features which are of limited distribution or are the best examples of a feature in the study area.

3.6 Slope Class Mapping

Slope class mapping for the Whaleback study area was accomplished through the use of a digital elevation model (DEM) data set and derived slope and aspect data to generate the mapping theme. Seven slope classes were defined, as follows:

Slope Class	Percent Slope
1	0 - 5 %
2	6 - 10 %
3	11 - 15 %
4	16 - 20 %
5	21 - 25 %
6	26 - 45 %
7	> 45%

A 1:20 000 scale DEM data set, as DMDF format ASCII files, was used. Coverage of the study area was achieved with six files containing a regular 25 meter grid from the SCOP process of Alberta Environmental Protection. DMDF format point data was translated to ArcInfo. Format files were generated by a custom C program, and ArcInfo point coverage was created with the elevation data attached. To generate the ArcInfo format DEM (grid, lattice), ArcInfo (ESRI) functions for point to grid conversion and for contour generation were used. No triangulation or surface fitting algorithm were required. Quality control of the generated DEM coverage was achieved through visual inspection of 10 m interval contours and validation of the mapsheet overlap areas. As well, a comparison was made of the generated contours and the original contours from 1:20 000 project data. Slope and aspect polygons were created using the ArcInfo GRID module. Output files were generated in .E00 export format. All ArcInfo processes were performed using a DEC Unix version of ArcInfo 7.0.4 software. All data sets were georeferenced in NAD27 datum and UTM projection (Pawlina 1997).

3.7 Sensitive Features Mapping

The parameters which defined the ecological land classification were used in conjunction with the consideration of additional biotic factors such as wildlife habitat values to determine and map classes of sensitivity to physical disturbance. Edaphic factors considered included physiography, slope, parent materials, drainage and depth to bedrock, among others. Biotic factors included the actual or potential occurrence of important plant or animal habitats within the unit.

Three sensitivity classes were defined within the Whaleback study area:

- **Low**
- **Moderate**
- **High**

Definitions and further discussion of these sensitivity classes are presented in Section 4.5 of this report.

3.8 Disturbance Features Mapping

Disturbance features within the study area were identified from aerial photograph interpretation and field investigations. Two classes of roads were mapped: graveled all-weather roads, including graveled secondary highways; and vehicle trails on mineral soil. Fencelines, usually consisting of barbed wire fences, were delineated, though insufficient time was available for field checking of all mapped fencelines to confirm the actual existence of fences within mapped lines for all cases. Cultivated areas, mapped as "agricultural", include those areas currently under tame forage production as well as previously cultivated areas which are now reverting to native vegetation. Timber harvesting areas were mapped as "cutblock". Other disturbance features identified and mapped in the study area included seismic lines, water reservoirs and dugouts, quarries (mapped as "pit"), farm sites or groupings of farm structures, corrals, individual buildings, and permanent snow fences.

3.9 Polygon Database Preparation

A digital database was prepared which incorporated the key characteristics of each map polygon. The database was formatted in dBASE IV and was structured in such a way as to be easily incorporated with spatial data files for future GIS analysis and presentation if required.

As specified in the study Terms of Reference, the following fields were incorporated in the database:

Dominant landscape parameters:

- polygon number
- ecosite
- parent material
- surficial expression
- proportion of polygon
- soil classification to subgroup level
- slope class

- drainage class
- surface soil texture
- subsurface soil texture
- vegetation community type(s)
- soil permeability class
- depth to bedrock (cm)
- depth to impermeable layer (cm)
- depth to water table (cm)
- surface rockiness class
- surface stoniness class
- shrink-swell potential class
- potential frost action class
- flood hazard class

Subdominant landscape parameters:

- parent material
- surface expression
- proportion of polygon
- soil classification to subgroup level
- slope class
- drainage class
- surface soil texture
- subsurface soil texture
- vegetation community type(s)

Database codes follow the Canadian System of Soil Classification (Canada Soil Survey Committee 1987) for the following parameters:

- parent material
- surface expression
- slope classes
- soil drainage classes
- soil subgroup classification
- soil texture

Potential frost action classes, surface rockiness classes, surface stoniness classes and shrink-swell classes are defined in Appendices A, B, C and D, respectively.

Vegetation type numerical codes are defined as follows:

Code	Vegetation Type
0	Unvegetated
1	Rough fescue/Parry oat grass - California oat grass
2	Mesic Terrace Grasslands
3	Rough fescue/hairy wild rye - smooth brome
4	Western porcupine grass and Columbia needle grass
5	Forb meadows
6	Sedge meadows
7	Limber pine/juniper (aMN)
8	Bearberry (bMN)
9	Canada buffaloberry/hairy wild rye (cMN; phases 1.1 and 2.1)
10	Creeping mahonia - white meadowsweet (dMN; phases 1.0, 1.1, 1.2, 2.0)
11	Canada buffaloberry/hairy wild rye transition - creeping mahonia/white meadowsweet (c/dMN)
12	Thimbleberry/pine grass (eMN)
13	Horsetail (gMN)
14	False azalea/grouseberry (eSA)
15	Bearberry/hairy wild rye (bSA)
16	Subhygric Aspen
17	Low shrubland
18	Willow thickets
19	Willow shrubland
20	Bog birch shrubland
21	Riparian
22	Agricultural

Polygons and map codes for all mapping themes were digitized using Intergraph Microstation software to produce .dgn files, which were then converted to .E00 files using ARC/INFO software.

Five thematic maps at 1:20 000 have been produced to accompany this report. These maps include:

- ecological land classification
- significant features
- disturbance features
- slope classes
- sensitive features

4.0 RESULTS

4.1 Ecological Land Classification Mapping

Map units (ecosites) are described in the legend accompanying the Ecological Land Classification map (Map 1). Biophysical features included in the legend are as follows: vegetation types; landform and surficial materials; soil classification; slope steepness (%); soil drainage; surface soil texture; subsurface soil texture; soil permeability; depth (cm) to bedrock, other impermeable layers or water table; surface rockiness class, surface stoniness class, shrink-swell potential, potential frost action class and flood hazard class.

Ecosites are arranged alphabetically in the legend according to the surficial material code which forms the first part of the map symbol. The following is a key to the surficial materials present in the Whaleback study area:

C	Colluvial
F	Fluvial
GF	Glaciofluvial
GL	Glaciolacustrine
M	Moraine
MR	Morainal veneers and blankets over bedrock
R	Bedrock
VR	Various colluvial (plus lesser residual and minor morainal) veneers and blankets over bedrock
W	Wetland
XR	Residual (plus lesser colluvial) veneers over bedrock

4.2 Description of Vegetation Community Types

Twenty-one vegetation community types were identified within the Whaleback study area. Due to the amount of variability throughout the study area, community types are only broadly defined, but where possible, correspond to ecosites identified in Archibald et al. (1996) and range types of Willoughby and Smith (1996) and Willoughby et al. (1996). As well, because of time constraints during the survey and because there is fairly extensive information on the grasslands from range management planning initiatives, a limited number of microplots were done in each site. Each community type will have a relatively wide variation from site to site.

The Whaleback study area straddles the Montane and Subalpine subregions and is essentially transitional between the two. It is a complex region of slope and aspect changes and elevations, characteristics which are reflected in vegetation community types typical of each subregion. As a

result of this variability, ecosites described for the Montane Subregion can occur within the Subalpine Subregion of the study area and vice versa.

The Whaleback study area is characterized by broad expanses of open grassland intergrading into complex associations of Douglas-fir, lodgepole pine, aspen and shrublands. The most common grassland type is the rough fescue/Parry oat grass-California oat grass community. Douglas-fir and lodgepole pine are the most frequently occurring forest species throughout the study area with Douglas-fir communities most commonly found within the Douglas-fir ecosite phase of the creeping mahonia/white meadowsweet ecosite (Archibald et al. 1996). Lodgepole pine is probably the most dominant forest cover and most of the pine communities are best defined by the false azalea/grouseberry ecosite. Aspen-dominated communities tend to be common along valley bottoms and lower slopes especially within the Montane Subregion. These communities are, generally, part of the thimbleberry/pine grass ecosite. Low shrublands, willow thickets, willow shrublands and bog birch shrublands are scattered throughout the study area and form complex associations with other vegetation communities in riparian areas and valley bottoms.

A description of each community type is presented below.

(1) Rough fescue/Parry oat grass-California oat grass

This grassland community type is common throughout the Montane and Subalpine subregions of the study area and is the most common grassland community of well to rapidly drained rolling and ridged mid- and upper slope areas in the study area. Parent materials tend to be predominantly medium- to coarse-textured colluvial, morainal or residual veneers over bedrock. The community type also occurs on similarly textured, level glaciofluvial terraces such as along the Livingstone River. Soils vary from well-developed Chernozems to Orthic Eutric Brunisols. Rough fescue (*Festuca scabrella*) and Parry oat grass (*Danthonia parryi*) are the most prevalent species but their relative dominance changes in response to slope, elevation, site position, moisture regime, degree of forest or shrub encroachment and grazing intensity. Common grass species include California oat grass (*Danthonia californica*), Idaho fescue (*Festuca idahoensis*) and sedges (*Carex* spp.). Slender wheat grass (*Agropyron trachycaulum*) tends to occur as a subdominant species on submesic to mesic terraces and moderate slopes. It can become prevalent within ecotonal communities of encroaching aspen (Willoughby et al., 1996) or Douglas-fir (*Pseudotsuga menziesii*). These ecotones occur between open grassland and Douglas-fir communities within the creeping mahonia/white meadowsweet ecosite (dMN) or between open grassland and mature aspen communities. Within grasslands ecotonal to the lodgepole pine (*Pinus contorta*) ecosite phase of the bearberry (bMN) ecosite, rough fescue remains the dominant grass species but Parry oat grass is replaced by pine reed grass (*Calamagrostis rubescens*).

With overgrazing, Kentucky bluegrass (*Poa pratensis*) or timothy (*Phleum pratense*) replace desirable native species such as rough fescue. At higher elevations hairy wild rye (*Elymus innovatus*) and awnless brome (*Bromus inermis*) tend to replace Parry oat grass. As slopes increase and moisture becomes a limiting factor, bluebunch wheat grass (*Agropyron spicatum*) becomes more prevalent. Western porcupine grass (*Stipa curtiseta*) also occurs sporadically on moderate submesic to subxeric slopes.

In ungrazed or lightly grazed rough fescue grasslands there is a low diversity and cover of other grasses and forbs. This is presumably from the shading of healthy, vigorous stands of fescue. The most common forbs tend to be three-flowered avens (*Geum triflorum*), cut-leaved anemone (*Anemone multifida*) and silky perennial lupine (*Lupinus sericeus*). On mesic terraces and lower slopes the most common forbs include yellow beardtongue (*Penstemon confertus*), sticky purple geranium (*Geranium viscosissimum*), woolly gromwell (*Lithospermum ruderale*) and low goldenrod (*Solidago missouriensis*). On somewhat drier slopes golden bean (*Thermopsis rhombifolia*), woolly cinquefoil (*Potentilla hippiana*) and graceful cinquefoil (*P. gracilis*) become more frequent. Pasture sagewort (*Artemisia frigida*) occurs most commonly on rapidly drained, coarse textured, shallow soils on steeper slopes and crests of ridges. Balsamroot (*Balsamorhiza sagittata*) tends to occur in patches on open, sunny slopes but is not a regularly occurring species throughout the study area.

Shrub species are usually patchy and sporadic throughout this community type. In the tall shrub layer, between 2.5 and 5.0 m, immature, successional Douglas-fir and lodgepole pine are infrequent. Depending on site conditions, low shrubs (i.e. less than 2.5 m in height) such as prairie rose, prickly rose (*Rosa acicularis*), saskatoon (*Amelanchier alnifolia*), shrubby cinquefoil, creeping juniper, immature Douglas-fir and snowberry (*Symphoricarpos albus*) can vary from common to intermittent. However, extensive patches of dense, low shrublands (discussed under (17) Low shrubland) are frequent throughout these grasslands, forming large transitional complexes of open grassland, semi-open grassland/shrubland and dense shrublands. These shrublands are commonly composed of mixed populations of prickly rose, buckbrush (*Symphoricarpos occidentalis*) and saskatoon. As well, on occasional drier, upper slope sites creeping juniper (*Juniperus horizontalis*) or bearberry (*Arctostaphylos uva-ursi*) can be quite extensive.

Communities that are transitional between the rough fescue/Parry oat grass community and the Douglas-fir ecosite phase of the creeping mahonia-white meadowsweet (dMN) ecosite can be characterized by an open overstory of occasional Douglas-fir between 2.5 and 16 m, with scattered lodgepole pine (*Pinus contorta*) and saskatoon to 5.0 m. Low shrubs such as snowberry, creeping juniper and saskatoon are also sporadic. Wild strawberry (*Fragaria virginiana*) tends to dominate with showy fleabane (*Erigeron speciosus*) co-dominant. Forbs such as graceful cinquefoil, prairie sagewort (*Artemisia ludoviciana*), gaillardia (*Gaillardia aristata*), northern bedstraw (*Galium boreale*) and cut-leaved anemone (*Anemone multifida*) are scattered throughout. As is typical with an encroached grassland, species composition changes in response

to the changes in moisture and light levels. Slender wheat grass can become dominant although rough fescue, Parry oat grass and Columbia needle grass (*Stipa columbiana*) remain common.

(2) Mesic terrace grasslands

This grassland community type is a complex typified by mesic terrace grasslands transitional between the rough fescue/oat grass, sedge meadows and bog birch shrubland community types. Due to the proximity of the sites in this community type to ephemeral or permanent watercourses, they tend to be heavily used by livestock. Therefore, they can also represent a number of the disturbed grassland communities[1] described in Willoughby et al. (1996). This community type occurs occasionally along Camp and White creeks as well as small unnamed creeks in both the Subalpine and Montane subregions. Parent materials tend to be fine to medium textured fluvial veneers or glaciofluvial deposits. Soils are generally Regosolic due to frequent flooding although the type can also occur on Black Chernozems. Although typical grasslands on mesic terraces tend to be dominated by rough fescue with Parry oat grass, California oat grass or sedge subdominant (as discussed in (1) Rough fescue/Parry oat grass-California oat grass community type), long term overgrazing, seasonal fluctuations in moisture levels from flooding and discharge areas from seasonal flash flood channels have created complex mosaics of vegetation. These are rich, productive grasslands with a large diversity of grass and forb species. Common grasses include Kentucky bluegrass, California oat grass and sedge. Where moisture levels remain high, tufted hair grass (*Deschampsia cespitosa*) or wetland sedges dominate.

Depending on the level of past overgrazing, rough fescue may or may not exist as a remnant species. Tame grasses such a awnless brome, creeping red fescue (*Festuca rubra*) and timothy also occur. Baltic rush (*Juncus balticus*) is quite common on some of the sites; it's presence is a good indicator of fluctuating high moisture levels. The most common forbs are three-flowered avens, common yarrow (*Achillea millefolium*), graceful cinquefoil (*Potentilla gracilis*), mountain cinquefoil (*P. diversifolia*), slender blue beardtongue (*Penstemon procerus*), yellow beardtongue and wild strawberry (*Fragaria virginiana*). Dandelion (*Taraxacum officinale*) is occasional but quite dense in some patches from overgrazing. Shrubs such as shrubby cinquefoil (*Potentilla fruticosa*) occur but are infrequent.

[1] Several sites within subsections (1) and (2) of this discussion can be considered as part of the Disturbed Grassland Communities discussed in Willoughby *et al.* (1996). For the purposes of this discussion, however, sites have been grouped more on physiognomic characteristics.

(3) Rough Fescue/hairy wild rye - awnless brome

This grassland community type tends to be found at elevations greater than 1640 m within the Subalpine Subregion. It can be considered an elevational intergrade from the rough fescue/Parry oat grass-California oat grass grassland community. Soils tend to be Regosols or Eutric Brunisols on medium- to coarse-textured colluvial veneers over bedrock. Typically the community type is found on subxeric to xeric, south to west-facing slopes. In the modal grassland for this community type, rough fescue is the dominant species with hairy wild rye co-dominant. Common graminoid species include sedges, California oat grass and purple reed grass (*Calamagrostis purpurascens*). Lodgepole pine (*Pinus contorta*) and whitebark pine (*Pinus albicaulis*) are occasional along ridge tops and scattered throughout the grasslands. Creeping juniper can often be quite dense underneath. With the decreased moisture of these sites, bearberry is extensive. Prickly rose, prairie rose (*R. arkansana*) or shrubby cinquefoil are usually present. On one lower elevation site, transitional between this community and the rough fescue/Parry oat grass community, chokecherry (*Prunus virginiana*), snowberry, white meadowsweet (*Spirea betulifolia*) and willow (*Salix* spp.) are also present.

There is a large amount of variability in these grasslands due, in part, from past grazing history and from the transitional nature of these grasslands with the rough fescue/ California oat grass community type and the adjacent coniferous community types. Awnless brome (either as an invader, *Bromus inermis* ssp. *inermis*, or the native, *B. inermis* ssp. *pumpellianus*) is common in patches within many of the sites sampled and it is possible that the native and non-native awnless brome subspecies have invaded a niche formerly occupied by hairy wild rye. These sites are similar to those identified in Willoughby et al. (1996) and to the modal sites discussed earlier, except for the dominance of awnless brome rather than hairy wild rye. Co-dominant or common graminoid species include sedges, Idaho fescue, Parry oat grass and pine reed grass. Forb species are quite diverse although each species tends not to be very extensive in occurrence. Silky perennial lupine is most prevalent on many sites within this community. Small-leaved everlasting (*Antennaria parvifolia*), yellow hedysarum (*Hedysarum sulphurescens*), fireweed (*Epilobium angustifolium*), northern bedstraw and prairie selaginella (*Selaginella densa*) are some of the more commonly occurring species.

The vegetative composition of sites within the community type which receive moisture from upslope can be more typical of lower elevation mesic rough fescue/Parry oat grass grasslands. Site characteristics such as elevation, parent material and soil type are comparable to other sites within this community. For example, showy aster (*Aster conspicuus*), northern bedstraw and cut-leaved anemone are quite common each with between 4 to 11% canopy cover. Hairy wild rye is infrequent but, as with other sites within this community type, awnless brome has become quite extensive.

(4) Western porcupine grass and Columbia needle grass

This community type is a compilation of western porcupine grass and Columbia needle grass community types so the composition of this type tends to be quite variable. No community types with high levels of either western porcupine grass or Columbia needle grass were reported for the study area in either Willoughby et al. (1996) or Willoughby and Smith (1996). However, rough fescue/western porcupine grass and Parry oat grass/western porcupine grass community types were identified on the Waldron Grazing Coop which is adjacent to the study area.

Although minor amounts of western porcupine grass (*Stipa curtiseta*) and Columbia needle grass occur throughout many of the rough fescue/oat grass community types, this community type is a compilation of grasslands with various needle grass species co-dominant or common. They occur in both the Montane and Subalpine subregions. Communities with needle grasses dominant are variable and found on moderately well to well drained, submesic to subxeric, level areas and mid-slopes. Parent materials tend to be morainal and colluvial veneers over bedrock or residual. Columbia needle grass seems to be a common species on several mesic, level or gently inclined grasslands within ecotonal grasslands transitional to aspen communities either in association with Richardson needle grass (*Stipa richardsonii*) or as the dominant grass species.

Kentucky bluegrass and Richardson needle grass are the dominant and co-dominant species along occasional submesic terraces along the Oldman River. Rough fescue and Columbia needle grass are common. High grazing pressure in the past and aspen encroachment have likely influenced the establishment of a stand dominated by an invader grass species as well as needle grass species associated with transitional grasslands. The most prevalent forbs include northern bedstraw, gaillardia, woolly gromwell and cut-leaved anemone. Prairie rose occurs as an occasional low shrub.

Columbia needle grass was also the dominant grass within a young mesic, seral aspen community. The understory vegetation is generally typical of a grassland but transitional to an aspen community. This community is typified by open aspen stands, to 4.5 m in height with the low shrub layer dominated by prairie rose. The vertical structure of the canopy is poorly developed as would be typical in a later successional aspen stand, the average shrub height was 0.5 m. Common wild rose, shrubby cinquefoil, creeping juniper and saskatoon are sporadic. The dominant forb is wild strawberry, which is typical of an aspen stand but forbs more representative of a grassland community such as silky perennial lupine, early yellow locoweed (*Oxytropis sericea*), woolly gromwell and yellow beardtongue also occur in minor amounts.

In contrast to the transitional aspen encroached grasslands on which Columbia needle grass is found, Western porcupine grass occurs occasionally as a common species either in rough fescue/sedge or Parry oat grass/sedge dominated grasslands. These grassland communities have developed on fine-textured colluvial and morainal veneers on submesic to subxeric east-

facing slopes. Other common grass species include northern wheat grass (*Agropyron dasystachyum*), Idaho fescue and bluebunch wheat grass. The most common forbs tend to be cut-leaved anemone, common yarrow, balsamroot, three-flowered avens and golden aster (*Heterotheca villosa*). Shrubs such as prairie rose and creeping juniper occur sporadically.

(5) Forb meadows

The forb meadow community type is occasional near ridgetops in small Douglas-fir openings in the Montane and Subalpine subregions. This type is characterized by lush, dense vegetation largely dominated by forbs and shrubs and occurs on Rego Black Chernozems on medium-textured eolian veneers. Fireweed (*Epilobium angustifolium*) tends to dominate this community with other forbs such as showy aster, mountain wild parsnip (*Lomatium dissectum*), three-flowered avens very common as well. Shrubs such as common wild rose (*Rosa woodsii*) and chokecherry can dominate in large, dense thickets throughout the community with grasses such as awnless brome and slender wheat grass co-dominant. Rough fescue, sedge, Idaho fescue and northern reed grass (*Calamagrostis inexpansa*) are common. Forb meadow communities tend to be a mixture of mesic to submesic species such as rough fescue and Idaho fescue which are more common to the rough fescue/oat grass type coupled with species found most often in nutrient and moisture-rich areas transitional between aspen stands and willow thickets. Such species would include showy aster, wild bergamot (*Monarda fistulosa*), fireweed, cow parsnip (*Heracleum lanatum*) and common nettle (*Urtica dioica*).

Nearer to the ridgetops, dense patches of mountain wild parsnip, cow parsnip and Canada goldenrod (*Solidago canadensis*) can dominate.

(6) Sedge meadows (Riparian)

Sedge meadows are most often found as part of riparian grassland, meadow and shrubland complexes. They tend to be small in size and transitional between well-drained rough fescue/oat grass communities and moderately well to poorly drained shrublands or willow thickets. They can likely be found in both the Montane and Subalpine subregions along floodplains. Typically the community type is found in subhydric depressional areas on poorly drained Rego Gleysols on fluvial parent materials. Sedges dominate with species such as redtop (*Agrostis stolonifera*) and fowl manna grass (*Glyceria striata*) common. Forbs characteristic of disturbed areas, in this case seasonal flooding, include common knotweed (*Polygonum arenastrum*) northern willowherb (*Epilobium ciliatum*), wormseed mustard (*Erysimum cheiranthoides*) and Bicknell's geranium (*Geranium bicknellii*). Forbs typical of wetland habitats include seaside buttercup (*Ranunculus cymbalaria*), dock (*Rumex* spp.) and mare's tail (*Hippuris vulgaris*).

(7) Limber pine/juniper (aMN)

This ecosite (Archibald et al. 1996) is the characteristic Douglas-fir community on rapidly to well drained, submesic to subxeric, west-facing mid and upper slopes within the Montane Subregion portions of the study area. Parent materials are predominantly shallow, fine- to coarse-textured, occasionally very stony, colluvial veneers over bedrock. Vegetation production reflects the density of canopy closure but becomes sparser nearer the ridge tops in response to decreasing moisture availability even though the overstory becomes more sparse. Along mid and upper-slope positions, douglas-fir is the dominant overstory and understory species and can form dense canopies. It reaches a height of between 10 to 32 m in the overstory to 10 m in the understory. On this ecosite sparse to frequent limber pine (*Pinus flexilis*) occurs in association with Douglas-fir and is the chief indicator species of this ecosite. This ecosite intergrades into dry grassy ridge tops where Douglas-fir and limber pine become quite sparse. The most prevalent component of the shrub layer, which is mainly low shrubs to 0.2 m tends to be juniper, either creeping juniper or ground juniper (*Juniperus communis*). Other shrubs include Canada buffalo berry (*Shepherdia canadensis*), prickly rose, white meadowsweet, bearberry, saskatoon (*Amelanchier alnifolia*) and shrubby cinquefoil. These species tend not be common and their presence throughout each site is not constant. Immature Douglas-fir is a major component between 2.5 and 5 m in height. Forb species tend to be fairly low in cover under the dense tree canopy although there can be a fairly large diversity of forb species found on some sites. The most common forbs tend to be silky perennial lupine, heart-leaved arnica (*Arnica cordifolia*), golden bean and showy aster. Yellow hedysarum, balsamroot, harebell (*Campanula rotundifolia*), northern bedstraw, gaillardia and prairie onion (*Allium textile*) are some of the occasional forbs found within this ecosite. The cover of grass species also tends to be quite sparse. Hairy wild rye or upland sedges occur most frequently. Other occasional species include rough fescue, Idaho fescue, Sandberg bluegrass (*Poa sandbergii*), fowl bluegrass (*P. palustris*), inland bluegrass (*P. interior*), awnless brome, bluebunch wheat grass, northern wheat grass and Parry oat grass. Many of these grass species are more commonly found upslope, on the dry ridge-top grasslands, and are indicative of the transition from this ecosite to communities characteristic of open ridgetop sites.

(8) Bearberry (bMN)

The lodgepole pine ecosite phase of this montane ecosite is occasional in the Subalpine Subregion. This ecosite tends to be somewhat less dry than the previous one.

This community is found on mesic, rapidly drained level to shallow slopes on coarse-textured glaciofluvial parent materials. Lodgepole pine is the dominant overstory and understory species. White spruce is occasional in the understory. The overstory pine reaches a maximum height of 17 m, understory species to 9 m. Species dominant in the shrub layer are generally indicative of the dry site conditions of this ecosite. This layer tends to be dominated by low growing species such

as dwarf bilberry (*Vaccinium caespitosum*), creeping juniper and bearberry. The few tall shrubs in the understory, Canada buffaloberry and, occasionally aspen (*Populus tremuloides*), are less than 2.5 m in height. Regenerating lodgepole pine to 5 m is occasional in the understory as well. Forb canopy cover is low, species such as wild strawberry, silky perennial lupine, felwort (*Gentianella amarella*) and yellow hedysarum are present. Grass species are sparse and include hairy wild rye, rough fescue, pine reed grass, California oat grass and spike trisetum (*Trisetum spicatum*).

(9) Canada buffaloberry/hairy wild rye (cMN, 1.1 and 2.1)

Sites within this ecosite fit into two ecosite phases based on differences primarily in successional stage and soil. Successional phase is toward Douglas-fir.

Sites within the Douglas-fir ecosite phase (c1.1) are in the Montane Subregion and are found on well to rapidly drained, inclined middle slopes in the study area. Parent materials tend to be fine- to medium-textured glaciolacustrine deposits. Soils are Solonetzic Black Chernozems. A dense overstory of Douglas-fir, up to 21 m in the overstory and 9 to 16 m in the understory, with sparse amounts of forbs and grasses, is characteristic of this ecosite. Occasional white spruce, lodgepole pine or limber pine can be found in the overstory. Tall willows occur sporadically in the understory. There are few species in the shrub layer because of the low light levels. Regenerating Douglas-fir to 5 m is occasional in the tall and low shrub layers. Shrubs, to 2.5 m in height, include snowberry, prickly rose, purple clematis (*Clematis occidentalis*) and white meadowsweet. Forbs are few and widely scattered and include species such as veiny meadow rue (*Thalictrum venulosum*), showy aster, bronzebells (*Stenanthium occidentale*), fairybells (*Disporum trachycarpum*), heart-leaved arnica, wild strawberry and red and white baneberry (*Actaea rubra*). The density of the grass layer tends to reflect the low light levels with scattered populations of sedge or pine reed grass.

Site disturbance can have an impact on understory species composition. Where livestock use sites as loafing areas, grass species composition reflects some level of disturbance from trampling. Species adapted to site disturbance such as Kentucky bluegrass, slender wheat grass and fringed brome (*Bromus ciliatus*) are occasionally present. Hairy wild rye is the most dominant grass within this community at 4% canopy cover.

Plant communities within the second ecosite phase (c2.1) are more open and are dominated by a sparse pine overstory with a well developed low shrub layer. Sites within this montane ecosite phase are found in the Subalpine Subregion on well drained lower slopes. Parent materials vary from coarse-textured morainal veneers over fine-textured glaciolacustrine veneers to medium-textured colluvial deposits. Soils often express weak solonetzic characteristics varying from Solonetzic Gray Luvisols to Solonetzic Black Chernozems. The open overstory is dominated by lodgepole pine from 12 to 15 m. There is no understory tree or tall shrub layer. The low shrub layer, to 2.5 m in height, is dominated by twinflower (*Linnaea borealis*) with creeping juniper, bearberry, dwarf bilberry and Canada buffaloberry subdominant. Occasional species include

prickly rose, white spruce, subalpine fir, aspen, willow and prince's-pine (*Chimaphila umbellata*). Forbs species are diverse but species usually occur as widespread single individuals. The most frequent forbs include heart-leaved arnica, wild strawberry and showy aster. Occasional species include yellow hedysarum, Lindley's aster (*Aster ciliolatus*), common fireweed (*Epilobium angustifolium*), northern bedstraw, harebell, cut-leaved anemone, yellow false dandelion (*Agoseris glauca*) and bronzebells. The diversity of grass species is limited as well but is dominated by pine reed grass with hairy wild rye subdominant. Species such as spike trisetum and rough fescue are occasional. The presence of rough fescue can indicate the transition into more open community types such as mesic shrublands or grasslands.

(10) Creeping mahonia/white meadowsweet (dMN; 1.0, 1.1, 1.2, 2.0)

Douglas-fir and lodgepole pine ecosite phases within this montane ecosite have productive, well developed strata of vegetation which develop on submesic to mesic moisture regimes and occasional subhygric sites. The majority of sites are in the Montane Subregion with occasional sites in the Subalpine Subregion. This ecosite is found primarily on moderately well to rapidly drained mid- and upper-slopes. One pine stand is on a level glaciofluvial terrace adjacent to the Livingstone River. Parent materials vary from medium-textured morainal and colluvial veneers and blankets over bedrock, medium-textured residuals, rubbly colluvial veneers over bedrock, and coarse-textured glaciolacustrine and eolian materials. Soils vary from Orthic Eutric Brunisols, Humic Regosols, Rego Dark Gray Chernozems to Orthic Dark Gray Chernozems. Depending on the level of succession, overstories may vary from Douglas-fir, Douglas-fir/white spruce, lodgepole pine/Douglas-fir or lodgepole pine/white spruce. Succession is toward pure or mixed stands of Douglas-fir or white spruce. Two ecosite phases are found in the study area, one dominated by a Douglas-fir overstory and the other by a pine overstory.

Relative ages of the Douglas-fir stands within the Douglas-fir ecosite phase are variable. In half of the Douglas-fir-dominated sites surveyed, Douglas-fir is moderate to dense in the overstory and averages from 17 to 25 m in height. In these communities, Engelmann spruce (*Picea engelmanni*) is usually an occasional species in the overstory. In the remainder of the communities in this ecosite phase, the ecosite is characterized by a moderate to dense understory of younger-aged Douglas-fir averaging between 9 to 13 m in height with only remnant mature Douglas-fir in the overstory. A well stratified shrub layer is lacking in all of these sites. Generally, the shrub layer ranges in height from 1.0 to 2.5 m. White meadowsweet and prickly rose are most frequent but seldom exceed 2 to 15% cover. Infrequently occurring species include wild red raspberry (*Rubus idaeus*), bristly black currant (*Ribes lacustre*), purple clematis, creeping juniper, snowberry and buckbrush (*Symphoricarpos occidentalis*). Forbs are also sparse. The most frequently occurring species include veiny meadow rue, heart-leaved arnica, Lindley's aster, cow parsnip and showy aster. Sporadic species are wild strawberry, western sweet cicely (*Osmorhiza occidentalis*), bronzebells, cream-coloured vetchling (*Lathyrus ochroleucus*), false Solomon's-seal (*Smilacina racemosa*) and wild white geranium (*Geranium richardsonii*). The diversity of grass species is

small with the cover of each species sparse. Pine reed grass is most common with occasional species such as alkali bluegrass (*Poa juncifolia*), hairy wild rye, spike trisetum, rough fescue and drooping wood-reed (*Cinna latifolia*).

One interesting observation noted during the 1996 field survey was the presence of dense arboreal lichens within the Douglas-fir ecosite phase of this ecosite as well as the Canada buffaloberry/hairy wild rye (cMN) ecosite discussed previously. These arboreal lichens are present on many of the north- to northeast-facing slopes within these ecosites.

On one subhygric site (which is atypical for this ecosite as defined in Archibald et al. 1996), white spruce is co-dominant with Douglas-fir in the overstory. Moderate amounts of white spruce and occasional Douglas-fir are found between 2.5 and 5 m. Balsam poplar (*Populus balsamifera*) is sporadic in this layer too. This stand exhibits a better stratified shrub layer than the previous sites, possibly due to higher moisture levels and other edaphic factors. White meadowsweet, northern gooseberry (*Ribes oxyacanthoides*) and wild red raspberry are dominant to 2.5 m. Infrequent species are common wild rose, purple clematis and buckbrush. Forb species such as wild strawberry, red and white baneberry, northern bedstraw and fairybells are sparse. In the grass layer, hairy wild rye is dominant, pine reed grass is subdominant while species such as timothy and slender wheat grass are occasional.

The pine-dominated ecosite phase (d2MN) within this ecosite is scattered throughout the study area and the sites surveyed are primarily in the Subalpine Subregion with sporadic occurrences in the Montane Subregion. Most of the sites are found on slight to steep, rapidly to moderately well drained middle slopes with one site occurring on a rapidly drained level terrace adjacent to the Livingstone River. Overstory densities of pine are variable but it is a major component of the overstory, with sporadic Douglas-fir. White spruce can occasionally be co-dominant. Overstory canopy is, on average, 19 to 20 m tall. A sparse understory of lodgepole pine, aspen or white spruce, to an average of 11 to 12 m, predominates. The shrub layer is composed chiefly of shrubs averaging below 2.5 m in height. The understory stratum, from 2.5 to 5 m, is limited to a few scattered white spruce and lodgepole pine. There is a good diversity of low shrubs below 2.5 m in most stands but these are sparse in cover. White meadowsweet and twinberry tend to be the most frequent species with common wild rose, creeping juniper and bearberry common. Occasional shrub species include prickly rose, twinberry, dwarf bilberry, willow, Canada buffaloberry, buckbrush, purple clematis, Douglas-fir and aspen. A sparse cover of forb species is common for most sites. Depending on the density of the overstory, forb cover ranges from 1 to 10%. The most frequent forbs are western meadow rue (*Thalictrum occidentale*), heart-leaved arnica and wild strawberry. Depending on the site and moisture conditions, cow parsnip, northern bedstraw, sweet-scented bedstraw (*Galium triflorum*), harebell, common red paintbrush (*Castilleja miniata*), bronzebells and yellow hedysarum are some of the species scattered throughout, with the occurrence and abundance of each dependant on site conditions. Grass cover is sparse, usually consisting of pine reed grass. Again, dependent on site conditions, hairy wild rye, purple

oat grass (*Schizachne purpurascens*), green needle grass (*Stipa viridula*), rough fescue, Kentucky bluegrass or sedge may be occasional.

(11) Canada buffaloberry/ hairy wild rye transition - creeping mahonia/white meadowsweet (c/dMN)

In the Montane Subregion, one site dominated by white spruce appears to be transitional between these two ecosites. This mature seral white spruce stand occurs on a well drained middle slope east of Camp Creek. The parent material is a medium-textured morainal blanket over bedrock with an Orthic Dark Gray Chernozem. The overstory is dominated by moderate density white spruce with occasional aspen. Overstory height averages at 18 m. The understory, between 5 and 13 m, is sparse with occasional white spruce and aspen. Low shrubs, to 2.5 m, are sparse as well. Prickly rose, snowberry and regenerating white spruce are the most common shrubs. Occasional species include wild red raspberry, twining honeysuckle (*Lonicera dioica*), bearberry, Canada buffaloberry and twinberry. Forb and grass cover is equally sporadic. Wild strawberry, sticky purple geranium (*Geranium viscosissimum*), wild white geranium, cream-coloured vetchling, hairy wild rye and purple oat grass are some of the forb and grass species occasionally found within this site.

This community type is likely common throughout Montane Subregion portion of the study area in ecotonal areas between middle slope grasslands and coniferous ecosites.

(12) Thimbleberry/pine grass (eMN)

In the study area, the aspen-dominated ecosite phase of this ecosite is most common, with the lodgepole pine-dominated ecosite phase occasional. The ecosite is most common throughout the Montane Subregion with a few occurrences in the Subalpine Subregion. These are nutrient rich communities where species such as thimbleberry and cow parsnip can be common.

These ecosite phases are found mainly on rapidly to moderately well drained middle slopes and occasionally on upper slopes. Parent materials are predominantly fine- to medium-textured colluvial and morainal blankets and veneers and, occasionally, coarse-textured glaciolacustrine deposits (atypical for this ecosite), most over bedrock. Moisture regimes are predominantly mesic with occasional submesic areas and subhygric depressions.

Within the various aspen-dominated ecosite phases, open to moderately dense aspen overstories with average heights of 9 to 20 m dominate. Depending on the successional stage of a community, successional species such as white spruce and lodgepole pine in the aspen overstory varies from non-existent to common in these early to mid-successional aspen stands. This

ecosite phase tends to be quite open between the secondary understory and the low shrub layer. In the secondary understory, which averages from 6 to 9 m in height, white spruce, lodgepole pine, Douglas-fir and aspen occur but are infrequent. Depending on the successional status and moisture regime of a particular stand the tall shrub layers, to 5.0 m, are frequently composed of sparse amounts of the same species in addition to occasional willow or saskatoon. The dominant species in the 2.5 m stratum are variable and include thimbleberry, aspen suckers, saskatoon, wild red raspberry, common wild rose, prickly rose and white meadowsweet. Minor components of this layer include snowberry, shrubby cinquefoil, Douglas-fir, bearberry and dewberry (*Rubus pubescens*). Moderate to high moisture levels throughout these sites can have an influence on the diversity and lushness of the forb layer. Cow parsnip can be predominant in some subhygric aspen stands and can account for almost half the canopy cover. Western sweet cicely (*Osmorhiza occidentalis*), a rare species, tends to be common in these subhygric stands as well. Aspect seems to account for the presence of green false hellebore (*Veratrum eschscholtzii*) in northeasterly aspect aspen stands where it can be the dominant forb cover. For the remainder of the stands, all generally of westerly or southerly aspects, wild strawberry, cow parsnip, wild white geranium, veiny meadow-rue, fireweed (*Epilobium angustifolium*), sticky purple geranium, showy aster and Lindley's aster are common. Occasional species include red and white baneberry, northern bedstraw, large-flowered stickseed (*Hackelia floribunda*), woolly gromwell, graceful cinquefoil, thin-leaved ragwort (*Senecio pseudaureus*), yellow beardtongue and western wood lily (*Lilium philadelphicum*). Grass species are variable between stands. Pine reed grass is dominant in most of the stands within this ecosite but other dominant species are sedge in a submesic aspen stand and fowl bluegrass and hairy wild rye co-dominant in one mesic aspen stand. Common species include slender wheat grass, smooth wild rye (*Elymus glaucus*), awnless brome and timothy. Occasional species such as purple oat grass, Columbia needle grass and rough fescue indicate the transitional nature of some of the aspen stands with the surrounding grasslands.

A pine-dominated ecosite phase (e1.1MN) is located within the Montane Subregion. This ecosite phase is characterized by dense lodgepole pine with an average overstory height of 20 m. In the understory, balsam poplar and successional white spruce are sparse. The understory shrub stratum tends, overall, to be sparse with low shrubs, to 2.5 m in height, such as white meadowsweet and thimbleberry most common. Red elderberry (*Sambucus racemosa*), smooth willow (*Salix glauca*), northern gooseberry and bristly black currant are occasional species. Forb and grass cover within mesic pine-dominated communities can be diverse. Cow parsnip and western meadow-rue (*Thalictrum occidentale*) are co-dominant and comprise approximately one-third of the total understory canopy cover. Green false hellebore (*Veratrum eschscholtzii*), fireweed and red and white baneberry are common. Infrequently occurring species include bronzebells, shining arnica (*Arnica fulgens*) and spreading sweet cicely. The presence of high amounts of thimbleberry, cow parsnip and green false hellebore are good indicators of the high nutrient status of these communities (Archibald et al. 1996). Only sparse amounts of pine reed grass and occasional hairy wild rye are present.

Balsam poplar stands are occasional within this ecosite. This ecosite phase is characterized by an open canopy of balsam poplar, to 14 m in height. No secondary understory exists and aspen between 2.5 and 5.0 m is sporadic. This mature edaphic community is unlikely to succeed to white spruce, no successional species are found in the understory. This is also a nutrient rich community as discussed for the other ecosite phases, however, the dominant shrub cover, to 2.5 m in height, is common wild rose with infrequent amounts of prickly rose, wild red raspberry and northern gooseberry. Snakeroot, prevalent in moist ecosystems, is the dominant forb in this community with Lindley's aster and cow parsnip co-dominant. Wild white geranium, wild strawberry and thin-leaved ragwort are some of the less frequent species. The grass layer is quite lush and depending on its proximity to tame grasslands can be dominated by naturalized or tame species such as awnless brome and timothy. A balsam poplar stand on an old floodplain adjacent to Bob Creek was surveyed. It has numerous meander scars so vegetation is lush and variable. Slender wheat grass and marsh reed grass (*Calamagrostis canadensis*) are very common as well and indicative of the seasonally high moisture levels of this flood plain. This balsam poplar stand is atypical for this ecosite but the understory vegetation appears be most typical of this ecosite.

(13) Horsetail (gMN)

A hygric aspen stand within the Montane Subregion and a subhygric white spruce stand in the Subalpine Subregion are representative of this ecosite. The aspen stand is found on an imperfectly drained middle slopes on medium-textured glaciolacustrine deposit while the white spruce stand occurs in an imperfectly drained depression on a fine-textured fluvial floodplain. Seasonal moisture variations are indicated in these stands by the moisture regimes, the presence of mottles and, to some extent, some of the vegetation. The old seral aspen stand is well stratified with early successional white spruce in the understory. Aspen is predominant in the overstory which averages to 17 m. The understory, to 8 m, is dominated by aspen as well with a few successional white spruce. From 2.5 to 5 m, species such as Douglas-fir, aspen and white spruce are occasional. The low shrub layer, to 2.5 m, is dominated by red-osier dogwood (*Cornus stolonifera*). Northern gooseberry is common with snowberry, saskatoon and twining honeysuckle occasional. Forb species are diverse but each species is sporadic. The most common species, averaging 3 to 4%, are Lindley's aster and wild strawberry. More infrequent species are shining arnica (*Arnica fulgens*), tall larkspur (*Delphinium glaucum*), squawroot (*Perideridia gairdneri*), thin-leaved ragwort, spreading sweet cicely (*Osmorhiza depauperata*) and wild white geranium. Northern reed grass (*Calamagrostis inexpansa*) is the predominant grass with sporadic occurrences of sedge, meadow foxtail (*Alopecurus pratensis*) and fowl manna grass.

The white spruce stand is a mature edaphic climax site adjacent to Camp Creek with an open overstory of white spruce to 15 m. The understory is quite open as well, with sparse cover of shrub, forbs and grasses. Willow and river alder (*Alnus tenuifolia*) with an average height of 9 m are occasional in the understory. Immature willow and river alder to 5 m also occur sporadically. The low shrub layer, to 2.5 m, is dominated by 4 to 5% cover each of northern gooseberry and wild

red raspberry. Sparse successional white spruce are scattered throughout this layer. Common nettle and purple avens (*Geum rivale*) are most frequent but seldom exceed 3% cover. Wild strawberry, woodland horsetail (*Equisetum sylvaticum*) and spreading sweet cicely are common while species such as common horsetail, mountain valerian (*Valeriana sitchensis*), red and white baneberry, cow parsnip, large-flowered stickseed are few in number. This site is likely use by livestock as a loafing area. This is borne out by the dominance, at 4% cover, of Kentucky bluegrass as the dominant grass species and the occasional presence of timothy. However, grass species are quite infrequent; the only other species noted was drooping wood-reed which is co-dominant with Kentucky bluegrass. Feathermoss species were not a significant part of this community as is typical with the ecosite definition.

(14) False azalea/grouseberry (eSA)

This is the most common pine ecosite on rapidly to well drained, subxeric to submesic, lower to upper slopes within the Subalpine Subregion. Aspects are variable. Parent materials are predominantly medium- to coarse-textured, occasionally rubbly, morainal and colluvial veneers over bedrock. One stand developed on glaciolacustrine materials. Open to dense lodgepole pine, between 12 to 20 m, dominates the overstory of stands within this ecosite with infrequent occurrences of Engelmann spruce. Lodgepole pine is seldom frequent in the understory but is often associated with other sparse occurrences of species such as aspen, white spruce, Douglas-fir and immature successional Engelmann spruce and subalpine fir (*Abies lasiocarpa*). Whitebark pine is co-dominant with lodgepole pine in one higher elevation (1885 m) stand. Average understory heights range from 6 to 13 m. The understory between 2.5 and 5 m is quite sparse with occasional Engelmann spruce, lodgepole pine, willow, green alder (*Alnus crispa*) and subalpine fir.

The density and diversity of shrubs, forbs and grasses species seems most influenced by canopy cover, slope and aspect. The trend to most diverse and highest prevalence of each species tends to be found on slopes between 0 to 40%, south to west facing slopes and/or open canopies. Shrub cover between 0.3 and 2.5 m is highly variable and is likely influenced by successional stage as well. Grouseberry (*Vaccinium scoparium*) and false azalea are key indicators of this ecosite and occur in sparse to dense amounts. (Due to the intergrading nature of species within this genus, specimens of grouseberry were identified in the field as size variants of low bilberry. As a result, low bilberry canopy cover has been taken to represent a mixture of grouseberry and low bilberry populations.) Generally, the most frequent shrubs in this ecosite are low bilberry, false azalea, dwarf bilberry (*Vaccinium caespitosum*), prickly rose, twinberry, bunchberry and willow. Depending on the community, common to sparse shrub species include white-flowered rhododendron (*Rhododendron albiflorum*), Douglas-fir, Canada buffaloberry, white meadowsweet, creeping juniper, aspen and purple clematis. Successional, immature subalpine fir is occasional in many of these communities. Showy aster, heart-leaved arnica and silky perennial lupine are the most dominant forbs. Common forbs include cream-coloured vetchling, wild strawberry, yellow hedysarum, spreading sweet cicely and white camas (*Zigadenus elegens*). Other associated

forbs include veiny meadow rue, harebell, thin-leaved ragwort, Lindley's aster, fireweed, yellow false dandelion, false Solomon's seal, dwarf scouring rush (*Equisetum scirpoides*), Menzie's catchfly (*Silene menziesii*), columbine (*Aquilegia* spp.) and nodding onion (*Allium cernuum*). Grass cover is dependent on site conditions but the most frequent species are pine reed grass, hairy wild rye and, in one stand, Wheeler's bluegrass (*Poa nervosa*). Sporadic species indicate the diversity of macro- and micro-climatic influences to which these stands are adapted. Infrequent species comprise of spike trisetum, rough fescue, muhly grass (*Muhlenbergia* spp.), upland sedges and northern reed grass.

(15) Bearberry/hairy wild rye (bSA)

Though not sampled during 1996 field investigations, this ecosite can be expected to likely occur in Sub-Alpine portions of the study area. The ecosite generally is found in the Sub-Alpine Natural Subregion on submesic to xeric southerly slopes (Archibald *et al.* 1996). The tree canopy is generally dominated by lodgepole pine, with succession to Engelmann spruce, though succession rates are slow due to dry site conditions and fire frequency. Common shrubs include bearberry, ground juniper (*Juniperus communis*), Canada buffaloberry and twinflower (*Linnaea borealis*), but shrub and forb layers tend to be sparse. However, the grass layer is often well-developed and dominated by hairy wild rye.

Within the study area, the ecosite is expected to occur on slopes with southerly aspects in VR1.4 and VR1.3 units in Sub-Alpine portions of the study area, as well as within some XR1.3 and XR2.2 units.

(16) Subhygric Aspen

Two subhygric aspen stands are atypical to the ecosites described in Archibald et al. 1996, and are not described by them. These sites occur in the Montane Subregion, one on a moderately well drained level terrace and the other on an imperfectly drained lower slope. Parent materials vary from fine-textured fluvial veneers over glaciofluvial floodplains to fine-textured morainal materials. Depending on the successional stage of the stands and grazing intensity by livestock, the understory trees and shrub layer may or may not be well stratified. Aspen is dominant in both stands, with an average overstory height of 12 to 14 m. The floodplain stand is, however, in a later successional stage with the presence of occasional white spruce. Balsam poplar is also sporadic in this overstory. This stand also has an understory of balsam poplar with aspen subdominant. Average understory height is 7 m. No understory exists in the younger seral aspen stand. Tall shrubs, to 5 m, are sparse in both stands. These include aspen, balsam poplar, willow, red-osier dogwood and prickly rose. It is possible that burning history has some relationship to the presence or lack of shrub cover in these stands. It is notable that the stand on the lowerslope apron has a very open understory with a few northern gooseberry whereas the terrace has a fairly

dense shrub understory with a predominance of prickly rose. Red-osier dogwood is common as well, with snowberry and saskatoon occasional. Forbs are diverse if generally low in canopy cover in both stands. Depending on the stand, showy aster, Lindley's aster or western Canada violet (*Viola canadensis*) predominate. Thin-leaved ragwort and wild white geranium are somewhat common. Species such as tall buttercup (*Ranunculus acris*), tall larkspur, wild strawberry, common yarrow, wild vetch (*Vicia americana*), common dandelion and northern bedstraw are occasional species found in both stands. Marsh reed grass is the dominant grass, however, timothy is almost as frequent in the lower slope stand. This can be attributed to invasion from the tame grasslands nearby. Sedge, meadow foxtail, Kentucky bluegrass and fowl bluegrass are all infrequent and indicative either of the moisture conditions or of past grazing history.

(17) Low shrubland

Patches of low shrubs and forbs are frequent along east and southeast-facing mesic, well drained lower to mid slopes within the Montane Subregion. These are minor seepage sites characterized by fine- to medium-textured colluvial veneers and morainal blankets over bedrock. Shrubs between 0.8 and 1.0 m high dominate but Douglas-fir to 3 m is occasional along the slopes. The predominant species of these shrublands varies, but, prickly rose, snowberry or saskatoon typically dominate. Douglas-fir, shrubby cinquefoil, common wild rose and chokecherry are infrequent. Forb cover is variable, depending likely on microsite conditions. On one site, sticky purple geranium was predominant, with wild bergamot approximately half as dominant. Species such a wild bergamot, sticky purple geranium, wild strawberry, three-flowered avens and woolly gromwell more commonly range from 2 to 8% cover. Infrequent species include large-flowered stickseed, smooth blue beardtongue (*Penstemon nitidus*), northern bedstraw, common yarrow, prairie sagewort, cut-leaved anemone and low goldenrod (*Solidago missouriensis*). The density of these shrublands influences the density and diversity of grasses. Commonly, the shrublands tend to contain some amount of grass species transitional to the rough fescue/ Parry oat grass type. On more open shrublands, species associated more with grasslands such as rough fescue, Parry oat grass and Richardson needle grass can become dominant and productive. As the canopy coverage of shrubs increases, these communities are more frequently dominated by low amounts of nodding brome (*Bromus anomalus*), fringed brome, slender wheat grass and Columbia needle grass. Less frequent species include timothy, redtop, alkali bluegrass, fowl bluegrass, June grass and northern wheat grass.

(18) Willow thickets

Communities of tall, overmature willow are scattered on subhygric to hydric depressions and terraces along ephemeral drainages throughout the Montane Subregion. Parent materials vary from fine-textured fluvial veneers to medium-textured morainal deposits and fluvial veneers over level organics. These sites are extensively used by livestock as loafing and watering areas and

heavily used by wildlife for browse and cover. They also provide excellent habitat for small mammals and birds. Warblers were frequently observed in these thickets during the 1996 field survey. Dense willows varying from 3.0 to 9 m tall predominate in the overstory with occasional Douglas-fir to 3 m. What separates these thickets from other willow shrublands is not only the height and density of the willow overstory but their overmature nature. In the low shrub layer, which averages from 0.5 to 2.5 m, there are few regenerating or suckering willows. Likely with the suppression of wildfires and lack of prescribed burning, these communities have become decadent and will eventually die out. Northern gooseberry, red-osier dogwood, prickly rose, wild red raspberry and common wild rose are sporadic throughout. Forbs and grasses are sparse, because they get shaded out by the dense overstory. It is notable, however, that many of these thickets are surrounded by dense patches of prickly rose, Canada thistle (*Cirsium arvense*) or common nettle. The presence of thistle and common nettle are, however, a direct result of the soil disturbance from livestock continually using these areas. Common nettle, cow parsnip and wild mint (*Mentha arvensis*) are most frequent in these communities. Harebell, Canada thistle, thin-leaved ragwort, mountain wild parsnip, wild white geranium, western Canada violet and western sweet cicely are regularly but sparsely occurring species. Marsh reed grass, tufted hair grass (*Deschampsia cespitosa*) and fowl manna grass are most common with Kentucky bluegrass, timothy, sedge, hairy wild rye, fringed brome and Wheeler's bluegrass occasional.

(19) Willow Shrubland

These riparian shrub wetlands are common along such creeks as Deep and Camp Creeks and are characteristic of shrub-dominated subhydric to hydric depressional and level terraces associated with riparian areas. These riparian areas are found throughout the Montane and Subalpine subregions. As is common with riparian communities, parent materials are variable, from organic blankets over fluvial floodplains, fluvial veneers over organic materials, medium-textured fluvial materials over bedrock, medium-textured glaciolacustrine materials and fine-textured glaciolacustrine over bedrock. Occasional tall willow, black spruce (*Picea mariana*) and water birch (*Betula occidentalis*) between 2.5 and 4.5 min height occur in some of the communities. Low willows dominate below 2.5 m with water birch and willow co-dominant in one community. Depending on the community and the site conditions, river alder can be common. Bog birch (*Betula glandulosa*), red-osier dogwood, shrubby cinquefoil and black spruce tend to be infrequent. Forbs are quite sparse but diverse throughout some communities. Occasional species include elephant's-head (*Pedicularis groenlandica*), veiny meadow rue, saline shooting star (*Dodecatheon pulchellum*), wild strawberry, yellow hedysarum, yellow angelica (*Angelica dawsonii*), large-leaved yellow avens (*Geum macrophyllum*), leafy bracted aster (*Aster subspicatus*), northern grass-of-parnassus (*Parnassia palustris*), common horsetail, wandering daisy (*Erigeron peregrinus*) and hairy speedwell (*Veronica peregrina*). Grass species are less diverse. Sedges, tufted hairgrass, small bottle sedge (*Carex utriculata*) and northern reed grass are most frequent. Depending on factors such as moisture regime and grazing history, species

such as slender wheat grass, Kentucky bluegrass, creeping red fescue (*Festuca rubra*), timothy, fowl manna grass and awnless brome are occasionally present.

(20) Bog birch shrubland

Bog birch communities are found on subhygric to hygric level terraces and middle slopes within the Subalpine Subregion, often associated with riparian areas. Parent materials vary from medium-textured glaciolacustrine to glaciofluvial deposits. The presence of mottles indicate that the communities develop in response to seasonally high water tables. Dense bog birch dominates the area with average canopy height of 1.0 m. Occasional species vary from those adapted to wet conditions such as willow and black spruce to those adapted to mesic or drier conditions such as bearberry and shrubby cinquefoil. It is evident that the composition of the forb and grass layers develops in response to a gradient of moisture conditions. On wetter sites, species such as northern valerian (*Valeriana dioica*) dominate, while on drier sites species such as smooth aster (*Aster laevis*) are frequent. These communities are transitional along a moisture gradient from sedge wetlands, willow shrublands, bog birch shrublands to mesic terrace grasslands. Species common to willow shrublands and mesic terrace grasslands can be found in varying amounts depending on site conditions, especially moisture. Dominant grass species are variable too. Sedge can be the dominant species with baltic rush subdominant while in another community, slender wheat grass is dominant with rough fescue subdominant. Tufted hairgrass or California oat grass are common with muhly grass, Kentucky bluegrass, creeping red fescue, Richardson needle grass and woodrush (*Luzula* spp.) occasional.

(21) Riparian

Riparian communities are common throughout the study area, in both the Montane and Subalpine subregions. They develop on a wide variety of parent materials and moisture regimes and are characterized primarily by their proximity to a permanent stream channel. Riparian communities are complexes of the subhygric aspen, willow shrubland, bog birch shrubland, mesic terrace grasslands and rough fescue/Parry oat grass communities types discussed previously. Two sites atypical to the sites listed above can also be considered riparian. They are characterized by imperfectly to poorly drained, hygric to subhydric, depressions or level terraces. Parent materials, for the community type, vary from medium-textured fluvial materials with organic material interspersed throughout to coarse-textured fluvial veneers over moraine. As is typical with a riparian area, species composition and density are variable. On one site, sporadic black and white spruce to 10 m in height were scattered through an open, 4.5 m tall community of willow and river alder. Smaller shrubs averaging 2.5 m in height consist of occasional willow, river alder, prickly rose and wild red raspberry. The sparsely vegetated understory is dominated with species mainly found in wetter areas. Cow parsnip and large northern aster are most common with Bicknell's geranium, narrow-leaved collomia (*Collomia linearis*), white angelica (*Angelica arguta*), common

horsetail, and common nettle scattered throughout. The most frequent grass is marsh reed grass with drooping wood-reed and inland bluegrass common. Sedges, Kentucky bluegrass, short-awned foxtail (*Alopecurus aequalis*) and keeled brome (*Bromus carinatus*) are occasional grass species.

On subhydric depressions, willow between 2.5 and 4.0 m is occasional. The dominant forb is common knotweed (*Polygonum arenastrum*) with northern willowherb subdominant. Common to sporadic forbs include seaside buttercup, wormseed mustard, mare's tail, rough cinquefoil (*Potentilla norvegica*) and alsike clover (*Trifolium hybridum*). This community is similar to the sedge meadow community discussed earlier but is somewhat drier and transitional to a mesic terrace meadow. Sedges are the predominant grass species with redtop common. Fowl manna grass, timothy, muhly grass, drooping wood-reed, fringed brome and Sandberg bluegrass are scattered throughout in common to infrequent amounts.

4.3 Significant Features

4.3.1 Significant Flora

Successful identification of rare plant populations is best accomplished through intensive survey methods designed to achieve this purpose. Project constraints precluded this. The biophysical survey methodology employed during 1996 field work resulted in six significant plant species being found in the Whaleback study area, of which three species, *Poa gracillima* (Pacific bluegrass), *Poa nervosa* (Wheeler's bluegrass) and *Hieracium cynoglossoides* (woolly hawkweed), appear to be new records for the study area. As well, *Angelica dawsonii* (yellow angelica), known to occur near the study area (Alberta Natural Heritage Information Centre 1997), was confirmed within the study area itself. The following discussion is based on the results of 1996 field work within the study area and on literature review.

The diverse topographic and geologic features of the Whaleback study area have provided habitat for a relatively large number of rare plant species. Up to 17 significant plant species occur within the study area, of which 13 species are currently listed on the "tracking list" of the Alberta Natural Heritage Information Centre (ANHIC), and four species are included on the "watch list". Explanations of these lists are provided in Appendix E. As well, eight additional plant species included on the "tracking list" occur in other areas immediately adjacent but outside the study area boundary (ANHIC 1997). Habitat is provided for a total of 25 significant plant species within the Whaleback study are and immediate vicinity, of which 21 species are rare plants included on the ANHIC "tracking list".

A species list of significant flora as described above that were identified in or adjacent the Whaleback study area by Geowest personnel and by previous researchers is presented in Appendix E.

Additionally, and of highly significant note, individual limber pine trees with ages between 250 and 575 years old occur in the study area (D. McIntyre, personal communication). The full extent of old-growth limber pine in the study area is not known to date and deserves further study. As well, old-growth Douglas-fir stands occur in the study area, with many trees over 400 years old (Kolar and Brawn 1986).

4.3.2 Significant Fauna

The Whaleback study area has been noted by numerous researchers (Bradley *et al.* 1977, Strong 1979, Wallis 1980, AWA 1985, Brown *et al.* 1986, Cottonwood Consultants Ltd. 1987, Fairbarns 1989, O'Leary *et al.* 1989, Downing and Karpuk 1994, Wallis 1994, AEP 1995) as providing biologically diverse and productive wildlife habitats. Included in the faunal assemblage of the area are species which are widespread and abundant, species which are considered threatened or endangered, species which are naturally scarce, and species which are commercially valuable. These species exhibit a diversity of ecological profiles. The physiographic variation within the Whaleback study area results in its wildlife inhabitants displaying considerable variation in migratory patterns (ranging from permanent residents to migrants), foraging guilds (ranging from carnivores to granivores), and breeding habitats (ranging from wetlands through tree canopies to rock outcrops).

The actual valuation of significance of faunal assemblages has been characterized in the past by a dependence on defined terms of reference and has, thus, been biased by its intended utility. As a result, there are no existing, widely applicable guidelines to assess significance of faunal species, however numerous attempts have previously been made to use a combination of rare species lists and current knowledge base to identify significant fauna as those species which may require special management and/or conservation attention (for example, see Bentz *et al.* 1995, Bradshaw *et al.* 1996, Bruhjell *et al.* 1997). For the purpose of this report, wildlife species have been considered as significant if they have:

a. been designated as such by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1996);

b. been designated as requiring management attention by the provincial Wildlife Management Division of Alberta Environmental Protection (AEP 1996);

c. been cited as being locally rare or uncommon in Alberta; or

d. been cited as being of relatively high abundance in the Whaleback study area.

COSEWIC determines the national status of wild species, sub-species, and separate populations in Canada. All native fish, amphibians, reptiles, birds, and mammals are included while

invertebrate animals are not. COSEWIC has identified five risk categories for Canadian wildlife species. as follows (COSEWIC 1996):

Extinct - A species formerly indigenous to Canada that no longer exists anywhere.

Extirpated - A species no longer exists in the wild in Canada but exists elsewhere.

Endangered - A species threatened with imminent extinction or extirpation throughout all or a significant portion of its Canadian range.

Threatened - A species likely to become endangered in Canada if the factors affecting its vulnerability are not reversed.

Vulnerable - A species particularly at risk because of low or declining populations, small range, or for some other reason, but not a threatened species.

Provincial populations of wildlife species, except fish, in Alberta have also been previously evaluated by Alberta Fish and Wildlife Division (AFWD 1991) and recently revised by Alberta Environmental Protection (AEP 1996); their status has been determined and classified as follows:

Red - Species whose populations have declined to non-viable levels or are at immediate risk of declining to non-viable levels in Alberta. They have been, or will be, considered for formal designation as Endangered or Threatened Species under the umbrella of the Alberta Wildlife Act.

Blue - Species which are also at risk but the threats that they face are less immediate. They are particularly vulnerable to non-cyclical declines in population or habitat, or to reductions in provincial distribution.

Yellow - Sensitive species which are not currently believed to be at risk. They may require special management to address concerns related to low natural populations, limited provincial distribution, or particular biological characteristics which make them vulnerable to habitat alterations. The Yellow list has been subdivided into Yellow A and Yellow B categories, defined as follows:

Yellow A: those species for which there has been concern expressed over long-term declines in their numbers; and

Yellow B: includes species that are (i) naturally rare but not in decline, (ii) naturally rare and have clumped breeding distributions, or (iii) are associated with habitats or habitat elements that may be deteriorating.

Green - Species not considered to be at risk. Their populations are healthy and often widespread and key habitats are generally secure.

Based on these criteria, numerous species belonging to the following assemblages have been identified as being significant in the Whaleback study area: ungulates, large carnivores, raptors, and passerines. The following sections detail these, and other, faunal groups in the Whaleback study area.

4.3.2.1 Avifauna

Based on geographic ranges described by Semenchuk (1992), Godfrey (1986), and Salt and Salt (1976), atlas data presented by Semenchuk (1992), and recent field observations in the study area (D. McIntyre, unpubl. data, personal communication; 1996 field work), up to 150 avifauna species can be expected to occur in the Whaleback study area, ranging from small perching birds through to large raptors. Included in the avifauna assemblage of the study area are common and widespread species such as the yellow warbler (*Dendroica petechia*) as well as peripheral range species such as American pipit (*Anthus rubescens*) and lazuli bunting (*Passerina amoena*), which are typically mountain-dwelling species, and horned lark (*Eremophila alpestris*) and American goldfinch (*Carduelis tristis*), which are typically southern grassland species.

Waterbirds

A general lack of wetlands of sufficient size and depth to provide habitat is a major limiting factor for water birds in the Whaleback study area. Only a few wetlands, the Oldman and Livingstone rivers, and some of the associated tributaries, provide aquatic habitats for waterfowl. Fifteen species of waterfowl have been recorded in the area and most of these are likely to be utilizing riverine waters, as standing aquatic habitats are extremely limited in the area. Barrow's goldeneyes (*Bucephala clangula*) and common mergansers (*Mergus merganser*) are secondary cavity nesters which have been shown to prefer to nest in tree cavities excavated by flickers (*Colaptes* spp.) in both deciduous and coniferous trees within 200 meters of the water's edge (Gauthier and Smith 1987).

The Oldman River has been recorded as providing local breeding records of harlequin ducks (*Histrionicus histrionicus*), a waterfowl species with very limited breeding distribution in Alberta. Alberta Environmental Protection and other sources have confirmed the presence of a few breeding pairs of harlequin ducks both at the Gap and upstream along the Oldman River (R. Quinlan, personal communication; D. McIntyre, personal communication). Atlas data from Semenchuk (1992) confirm the species as having Cordilleran affinities, as 31 of the 39 breeding records were from the Rocky Mountain Natural Region and the remaining were from the adjacent Foothills Natural Region. Harlequin ducks occur in two distinct and widely separated populations in Canada. The Eastern population has been designated by COSEWIC (1996) as *"threatened"* whereas the Western or Pacific population, which reach the eastern limit of their range in Alberta, is quite large, with an estimated population of over one million (Semenchuk 1992). However, in

light of its restricted breeding range in Alberta, as well as unconfirmed reports of local declines, AEP (1996) has designated the species as "yellow (A)-listed". The dependence of harlequin ducks on fast-flowing mountain streams renders them extremely susceptible to detrimental effects on stream ecology which may be caused by various anthropogenic sources (Breault and Savard 1991).

Eight species of 'shorebirds' also occur at varying levels of abundance in the study area but they, too, are limited by the lack of wetland habitats. Among the shorebirds which may nest in appropriate habitats along the major river systems and drawn down wetlands are the upland sandpiper (*Bartramia longicauda*), a yellow A-listed species, and long-billed curlew (*Numenius americanus*), a species which is blue-listed in Alberta and designated federally as a *"vulnerable"* species. The actual status of upland sandpipers in Alberta is unclear at this time, as increases in populations across Canada have been reported by Robbins *et al.* (1986). However, AFWD (1991), AEP (1996), and Pinel *et al.* (1991) indicate that upland sandpiper have disappeared from much of their formerly extensive range in Alberta. Semenchuk (1992) reports that over 70 percent of recorded breeding in Alberta occurs in the Grassland Natural Region. The native grassland habitats on which this bird thrives are also found in disjunct portions in the Whaleback montane. Extralimital breeding records for the species have been documented from the Whaleback area, Waterton Lakes National Park, and the area south of Grande Prairie.

The long-billed curlew (*Numenius americanus*) is one of two bird species within the Whaleback study area that has been designated as *"vulnerable"* by COSEWIC (1996). Within Alberta, AEP (1996) has blue-listed the resident population of long-billed curlews to reflect the status of the bird as being '*at risk*'. Breeding activity of long-billed curlews within the Whaleback study area has not been confirmed (R. Quinlan, personal communication). However, documentation of nearby breeding in areas east of, and adjacent to, the study area in habitat that is similar to that found within the Whaleback indicates that potential for range expansion into appropriate grassland habitats may be feasible, if not already occurring.

The primary limiting factor for long-billed curlews throughout their range has included habitat degradation and habitat loss throughout most of its traditional native range. The widespread use of agricultural practices and cultivation and the near total replacement of native grasses with introduced grass species, have prompted changes in physiognomy of vegetation communities (De Smet 1992). The actual effects of grazing on long-billed curlew populations is unclear. Many researchers have reported high breeding densities of long-billed curlews to be found in habitats undergoing light to moderate grazing (Pampush 1980, Ohanjanian 1987, Redmond and Jenni 1986). However, others such as Sugden (1933), Timken (1969), Fitzner (1978), and Jenni *et. al.* (1982) found grazing to be a major limitation on populations of curlews, with nest abandonment being the most notable effect of livestock introduction on long-billed curlew ranges. As a result of the bird's strong fidelity to its habitats, these disruptive changes may have cumulatively induced the marked long-term decline in long-billed curlew numbers (Renaud 1980, Pampush and Anthony 1993).

Numerous authors have characterized the typical habitat of long-billed curlews as being dominated by dry mixed grass with low vegetative cover and no visual barriers for nesting habitat (King 1978, Renaud 1980, Redmond and Jenni 1986, De Smet 1992, Pampush and Anthony 1993, Paton and Dalton 1994). In addition, long-billed curlews have been shown to select nesting sites based on the height of vegetation (preferably shortgrass meadows) and the spacing of grass clumps (Allen 1980, Pampush 1980, Pampush and Anthony 1993, Paton and Dalton 1994). Pampush (1980) identified the most critical determinants of nesting habitat for the long-billed curlew as: (i) short vegetation; (ii) bare ground; (iii) shade; and (iv) abundant invertebrate prey species. Suitable combinations of these factors are more common in the Grassland Natural Region of southern Alberta, but also occur in the Whaleback, where long-billed curlews have the potential to expand their range westward, as well as altitudinally.

Raptors

The generic name applied to this group of predatory birds refers to both Falconiformes and Strigiformes orders. Based on geographic distributions identified by Salt and Salt (1976) and Semenchuk (1992), as well as on personal field observation in the study area (D. McIntyre, personal communication; 1996 field work), up to 20 species of hawks, falcons, eagles, and owls are anticipated to nest in appropriate habitats of the Whaleback study area to some extent. A few of these species, such as red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) are habitat generalists and are common throughout much of the province. Other species, such as bald eagle (*Haliaeetus leucocephalus*), prairie falcon (*Falco mexicanus*), and golden eagle are specialists that have strict habitat requirements, while still others such as barred owl (*Strix varia*) and Cooper's hawk (*Accipiter cooperii*) have ranges in Alberta that are fairly restricted.

Among the 20 resident diurnal and nocturnal raptor species in the Whaleback study area, two are federally designated by COSEWIC (1996) - the peregrine falcon (*Falco peregrinus*) is *"endangered"* and the short-eared owl (*Asio flammeus*) is *"vulnerable"*. The provincial government (AEP 1996) has identified the peregrine falcon as red-listed and the short-eared owl as blue-listed. Osprey (*Pandion haliaetus*), bald eagle, Cooper's hawk, northern goshawk (*Accipiter gentilis*), northern harrier (*Circus cyaneus*), prairie falcon, barred owl, and great gray owl (*Strix nebulosa*) are all yellow-listed species.

The peregrine falcon is a migratory raptor that formerly nested throughout the North American boreal forest from the sub-arctic tundra to the Gulf of Mexico. However, widespread decline of these populations during the mid-1900s as a direct result of hydrocarbon pesticide use resulted in the extirpation of the species from most of its range in the United States and southern Canada. Semenchuk (1992) reported the peregrine falcon as having the most widespread distribution of any falcon in the world as it breeds on every continent except Antarctica. Of the three sub-species of peregrine falcon that breed in Canada, only one - *Falco peregrinus anatum* - is reported to

breed in Alberta and its distribution is limited largely to the extreme northeastern corner of the province. Some breeding pairs, however, are scattered elsewhere in the province, particularly on cliffs along major rivers in central and southern Alberta and in some urban settings. Appropriate habitats in the Whaleback study area are found in the cliff banks of the Oldman River, although there are currently no known nesting peregrines in the area.

The indiscriminate use of certain chlorinated hydrocarbon pesticides, most notably dichlorodiphenyl-trichloroethane (DDT), has been implicated as the underlying cause of decline of peregrine falcons, including those in the southern Rocky Mountains area of Canada (Enderson *et al.* 1982). This pesticide was banned from use in Canada in 1969 and the United States in 1972, however by 1975 the subspecies *F. p. anatum* had been extirpated over much of its range east of the Rocky Mountains and south of the Boreal Forest. In Alberta, by the mid-1970s, only five of 73 known historical nest sites were occupied by breeding pairs, all of these within a small remnant population in northeastern Alberta (Court 1994). As a result, recent summer observations of peregrine falcons in the Whaleback study area (1996 field work; D. McIntyre, personal communication) are significant due to the potential for increased fecundity and range expansion of the species. Court (1994) cites numerous Alberta Wildlife Management Division sources as confirmation that the northeastern Alberta population is continuing to grow, however very little data is currently available regarding the southern Alberta populations.

While osprey and bald eagle are both anticipated to occur in increasing abundance further east along the lower reaches of the Oldman River, migrants and some nesting individuals are also expected in appropriate habitats within the Whaleback study area, particularly where fish-bearing streams are bordered by woody vegetation large enough to support bulky nest structures. The cliff-nesting prairie falcon and golden eagle, however, are afforded considerable habitat in the Whaleback study area and, as a result, the region houses numerous nests of these species. The prairie falcon, in particular, is a grassland species of dry, open country and its range extends west into the Whaleback study area, marking one of the westernmost documentations of prairie falcon nest sites in Alberta.

Breeding prairie falcons in Canada are at the northern limit of their range and thus their populations are relatively small. In recognition of this fact, the Alberta population is managed as a yellow (A) listed species (AEP 1996), while no federal designation is currently given to the species by COSEWIC. The status of prairie falcons in Canada has been assessed periodically by COSEWIC (Woodsworth and Freemark 1981, Kirk and Banasch 1996) and has twice been assigned as a species *"not at risk"*. This designation for the species indicates that prairie falcons have stable but increasing, albeit small, populations in Canada. However, the lack of recent productivity and nesting density data, and the fact that this population is at the northern fringe of its range, have prompted Kirk and Banasch (1996) to describe the species as being one of long-term concern which should be monitored to ensure its survival.

Generally, dry open areas, particularly where there are cliffs or eroded river banks are preferred habitat for prairie falcons (Beauvais *et al.* 1992, Squires *et al.* 1993). Throughout much of its Canadian range, prairie falcons are found nesting in the vicinity of canyons and coulees in badland-type topography. However, use of alpine and subalpine habitats has also been reported, particularly in British Columbia (Campbell *et al.* 1990), where *"steep, rocky cliffs, escarpments, and outcrops or buttes adjacent to open areas"* are extensively utilized. Sub-alpine habitat features such as rock outcrops and escarpments provide nest sites for prairie falcons in the Whaleback study area, as a few eyries have been reported from the vicinity (Wallis 1980, 1994, AWA 1985, R. Quinlan, personal communication, D. McIntyre, personal communication).

In southern Alberta, prairie falcons have been shown to be highly dependent on ground squirrel populations as a staple prey item (Hunt and Holroyd, in press). Hunt (1993) also reported that native prairie habitats harboring ground squirrels was used significantly more often than expected based on availability and, by contrast, irrigated croplands were used significantly less than expected based on their availability. Furthermore, USDI (1979) indicate that prairie falcon productivity and nest success are lower in areas where they feed on birds than in areas where they feed on mammals. For these reasons, recent declines in populations of Richardson's ground squirrels in prairie habitats of southern Alberta have been implicated as a potential reason for the local decline of some populations of prairie falcons.

The Alberta population of prairie falcons are the stronghold of the Canadian population of this species. Woodsworth and Freemark (1981) estimated that 250 pairs of prairie falcons nested in Alberta, with an additional 50 pairs in Saskatchewan and 6 pairs in British Columbia. The most recent estimate reported for Canada is 250-500 pairs (Kirk and Hyslop, in press). Despite an apparently stable population, habitat loss continues to be considered a dire threat to prairie falcon populations (Noble *et al.* 1993), therefore the trend towards converting native prairie to cropland, such as is prevalent in southern Alberta, is of paramount concern. Appropriate habitats elsewhere in the species' range, such as the montane grasslands, coulees, and river banks in the Whaleback study area, will be an eminent component of the continued growth of the population in Canada.

Golden eagles have somewhat similar habitat requirements to those of prairie falcons in that they, too, require cliff ledges or large river canyons for nesting throughout most of their range (Semenchuk 1992, DeGraaf *et al.* 1991, Palmer 1988). Large trees are also used in some areas, but has not been documented to a great extent in Alberta. Numerous golden eagle nesting observations and eyries have been recorded from the Whaleback study area, as an interspersion of both nesting and foraging habitat (as well as suitable prey levels) provide ecological conditions which favor the viability of golden eagle populations.

The status of golden eagle in Canada has previously been assessed by COSEWIC and deemed to be "not at risk" (DeSmet 1987) and this status has recently been re-confirmed (Kirk 1996). Both authors cite *"apparently healthy populations in some areas ... with numbers remaining high and stable with some fluctuations in productivity in relation to prey abundance."* The Canadian population has been estimated at over 10,000 pairs, with a North American population of between

50,000 and 100,000 individuals. In Alberta, Semenchuk (1992) cites a stable population estimated at 100-500 breeding pairs of golden eagles. Atlas data from Semenchuk (1992) show that the majority of breeding records of golden eagles in Alberta come from the Grassland Natural Region of southern Alberta, where coulees, steep river banks, and canyons are used extensively for nesting.

Golden eagles eyries have also been recorded extensively in the Rocky Mountain Natural Region, where high cliff ledges, rocky outcrops, escarpments, and rock bluffs are common habitat features. Cramp and Simmons (1980) identified the most important requisite for golden eagle habitat as remote, open (often wilderness) areas for hunting. Slopes and plateaus are favored because they provide updrafts for soaring and allow all around vision. Because the Whaleback study area is characterized by complex and repeated slope, aspect, and elevational changes, it contains an excellent example of interspersion of suitable foraging habitat in close proximity to nesting habitat, a criteria which has been shown by Palmer (1988) as being a requisite to managing most raptor populations, including golden eagles.

The diverse prey base present in the Whaleback study area is another characteristic of the region that makes it particularly attractive to golden eagles. The majority of golden eagles' diet consists of small to medium sized mammals. While hoofed mammals such as deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and domestic livestock make up less than 5% of the diet, much of this is in the form of carrion and is not actively preyed upon. In the Whaleback study area, pika (*Ochotona princeps*), snowshoe hare (*Lepus americanus*), two species of chipmunks (*Tamias* spp.), two species of marmot (*Marmota* spp.), three species of ground squirrels (*Spermophilus* spp.), and numerous microtine rodents are available to golden eagles as a primary prey source. Human-induced habitat alterations which affect the abundance of these prey species are presently thought to be the major limiting factor for golden eagles throughout their western Canadian range. The Whaleback region is one of the few remaining wildlands in Alberta which retain this diversity of small mammal prey species.

Numerous environments which have been identified as significant features in the Whaleback study area have specific features which may be of value to local populations of prairie falcons and golden eagles. Nesting and foraging habitats for these two species in particular are found in all three significant habitat elements within the study area - the Whaleback montane, the Livingstone sub-alpine, and the Oldman River.

Among the group of nocturnal raptor species that inhabit the Whaleback study area, three species are listed as requiring special management attention by AEP (1996) - the barred owl (*Strix varia*) and the great gray owl (*Strix nebulosa*) are yellow (B)-listed in Alberta while the short-eared owl (*Asio flammeus*) is blue-listed. Of these species, only the short-eared owl is designated by COSEWIC (1996) as a nationally *"vulnerable"* species.

The short-eared owl is a holarctic breeder traditionally thought to be limited largely to the Parkland and Grassland Natural Regions in Alberta. Breeding ranges described in Salt and Salt (1976) and

atlas data from Semenchuk (1992) both suggest that short-eared owls are absent from the Rocky Mountains and only occur very rarely, at best, in the Foothills. However, recent confirmed, but unpublished, records of short-eared owls breeding in the Whaleback study area and adjacent regions (D. McIntyre, R. Quinlan, personal communication) may force revisions to the species' expected range in Alberta. The status of short-eared owls has been assessed by COSEWIC and the species has been designated as *"vulnerable"* (COSEWIC 1996). In Alberta, AEP (1996) has designated the short-eared owl as blue-listed, with both provincial and federal sources citing a significant decline in population throughout the species' Canadian prairie range.

Within the Whaleback study area, short-eared owls have been documented as occasional breeders in the vicinity (R. Quinlan, personal communication), although their occurrence, as with elsewhere in their range, is scarce. Their habitat preferences tend to include relatively open habitats such as grassland, grassy or brushy meadows, marshland, pastures, stubble fields, croplands, and previously forested areas that have been cleared (Eckert 1974, Clark 1975, Duebbert and Lokemoin 1977, Godfrey 1986, Semenchuk 1992, Cadman 1994). This type of open habitat may be conducive to the owls' ground nesting tendencies and ability to forage. The short-eared owl and snowy owl (*Nyctea scandiaca*) share the distinction of being the only owls that regularly nest on the ground. The Whaleback study area provides appropriate habitat for short-eared owls throughout the lower elevations wherever suitable grassland meadow and marshes are available. The suitability of the habitat is predominantly determined by the availability of nesting and resting cover, and the availability and abundance of prey species, particularly small microtine mammals.

Conservation efforts targeting short-eared owls should focus primarily on habitat loss. Wetland drainage and land conversion for agricultural uses, urban development, and expanding recreational facilities have undoubtedly resulted in a considerable reduction in short-eared owl populations throughout the species' range. Direct habitat loss, accompanied by the fragmentation of remnant habitats, have further reduced the quantity and quality of critical habitat for the short-eared owl (Cadman 1994), as 80% of the native Canadian prairie landscape and approximately 99% of the tall grass prairie have been altered by agriculture, urbanization, and industrialization (Scott 1991).

Passerines

Traditional habitat management, both in Alberta and elsewhere in North America, has focused on the perpetuation of harvestable populations of game species. Among avian species, the historical emphasis on waterfowl as gamebirds and the relative lack of attention given to non-game birds has only recently been amended to include active management and conservation of all species. *Non-game birds* are distinguished more by a process of elimination than by a precise statement of definition. For purposes of identifying significant non-game avifauna in the Whaleback study area,

we have defined the group of *non-game birds* as the neotropical migrant landbirds, or those that breed in the nearctic and migrate south to the neotropics of the southern hemisphere.

These avian species, also collectively referred to as passerines, songbirds, or perching birds, are of particular concern because they have experienced drastic population declines due, in large part, to deforestation of tropical wintering areas. However, the fragmentation of breeding habitat in temperate North America has also contributed cumulatively to the declining population trends (Diamond 1988, 1991, Thiollay 1992, Petit *et al.* 1993). A total of 96 species, representing numerous taxonomic groups such as woodpeckers, hummingbirds, flycatchers, swallows, blackbirds, vireos, warblers, and sparrows, are included in this group of avifauna within the Whaleback study area.

Researchers have long hypothesized that a correlation existed between certain habitat features and components of an area's breeding avifauna (MacArthur and MacArthur 1961). This concept has been accepted and built upon by modern conservation biologists, who now widely recognize that the distribution and abundance patterns of avifauna species reflect the composition and structure of vegetation or habitat communities. Among the 96 species included in this group of non-game birds in the Whaleback study area, only one - the loggerhead shrike (*Lanius ludovicianus*) - is federally listed by COSEWIC as *"threatened"*. An additional 13 species, along with loggerhead shrike, are designated as *"yellow-listed"* in Alberta by the provincial government (AEP 1996):

- black swift (*Cypseloides niger*)
- pileated woodpecker (*Dryocopus pileatus*)
- cordilleran flycatcher (*Empidonax occidentalis*)
- Steller's jay (*Cyanocitta stelleri*)
- Clark's nutcracker (*Nucifraga columbiana*)
- brown creeper (*Certhia americana*)
- marsh wren (*Cistothorus palustris*)
- rock wren (*Salpinctes obsoletus*)
- American dipper (*Cinclus mexicanus*)
- loggerhead shrike
- Townsend's warbler (*Dendroica townsendi*)
- western tanager (*Piranga ludoviciana*)
- clay-colored sparrow (*Spizella pallida*)
- western meadowlark (*Sturnella neglecta*)

Many of the species on the aforementioned list are actually representative of faunal elements other than Cordilleran, the exceptions being Clark's nutcracker, American dipper, and Townsend's warbler. Many of the species are actually representative of a Campestrian faunal element and have central ranges with affinities to grassland habitats of southern and southeastern Alberta.

As obligate users of threatened grassland habitats in the southern prairies, species such as loggerhead shrike occur in the Whaleback study area as range peripherals, making use of montane grasslands in the region. Loggerhead shrikes exhibit a preference for grassland habitats that are usually heavily grazed or mowed. They also require shrubs and trees for nesting and perching, although human structures such as fence posts and utility wires are also commonly used to fulfil some of these needs (DeSmet 1993). In Canada, most loggerhead shrikes breed in the southern portions of the prairie provinces where habitat limitation is the most often cited cause for recent population declines of the species. Hands *et al.* (1989) describe breeding populations of the species to have declined at an annual rate of approximately 3% since 1966. As a result, populations of loggerhead shrikes on the Canadian prairies have been listed as *"threatened"* by COSEWIC since 1986 (COSEWIC 1996). The loss and degradation of both breeding and wintering habitats due to intensive agricultural practices, which remove shrubs and shelterbelts, continue to be cited as the primary limiting factor for extant populations (Telfer 1992). Brooks and Temple (1990) and Prescott and Collister (1993) have postulated that much apparently suitable habitat remains unoccupied in Canada and the United States. In this regard, the significance of the Whaleback study area for loggerhead shrikes lies in its capacity to provide additional habitat and allow for a possible range expansion.

In general terms, the complexity (both of the forest strata and of the forest / grassland mosaic) is the key to diversity of avian community structure in the Whaleback study area. Vertical and horizontal heterogeneity (*sensu* Hunter 1990) provide differentiated and stratified niches, particularly for the region's songbird populations. The size, extent, structure, and interspersion of habitat patches are critical factors which determine use of appropriate habitats by various avifauna species. Either anthropogenic fragmentation of large tracts of forest or the natural successional pathways which produce forest clearings and canopy gaps inherently produce ecological edges, or ecotones, which have been shown to deter forest interior species such as winter wren (*Troglodytes troglodytes*) but, conversely, to attract edge-associated species such as brown-headed cowbird (*Molothrus ater*).

4.3.2.2 Mammals

Geographic distributions of mammals in Alberta, provided by Smith (1993), indicate that 57 mammal species can be expected to occur in the Whaleback study area. Included in the mammal fauna of the region are species guilds as varied as small microtine rodents, fossorial rodents, large and vagile carnivores, ungulates, chiropterids, and mustelids. Among these species, some such as least weasel (*Mustela nivalis*), deer mouse (*Peromyscus maniculatus*), masked shrew (*Sorex*

cinereus), and mule deer (*Odocoileus hemionus*) are widespread across most habitats in the province and are fairly common in the Whaleback study area as well. Other species, however, occur on the periphery of their Alberta range in the Whaleback study area. Species such as pika, hoary marmot (*Marmota caligata*), and bighorn sheep (*Ovis canadensis*) are typical mountain species which range prevalently to the west of the study area but also use appropriate habitats in the Whaleback study area on occasion. Long-tailed weasel (*Mustela frenata*), bobcat (*Lynx rufus*), and sagebrush vole (*Lagurus curtatus*) are also present in the Whaleback study area even though their distributional strongholds in Alberta are centered in the grasslands of the prairies to the south and east of the study area.

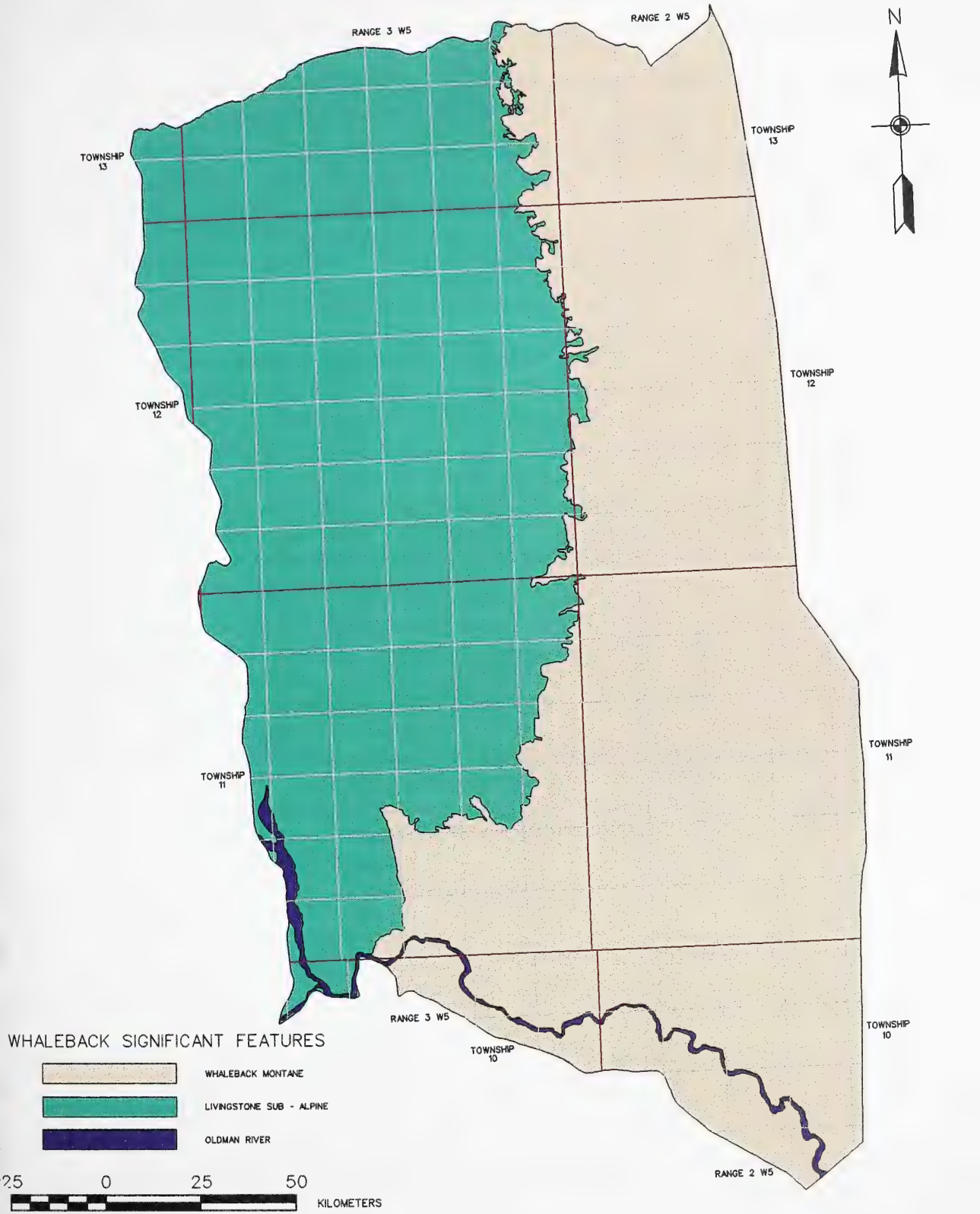
Ungulates

Section 4.1 of this report has highlighted the diverse mosaic of vegetation communities which characterizes the Whaleback study area. The system of ridges and valleys within the study area creates a repeated and predictable pattern of grassland and forest, the community structures of which are highly dependent on aspect and elevational shifts. Also discernible within the study area is a northward trend towards habitats that are increasingly dominated by forested environments. These vegetation communities are actually an expression of a variety of biophysical parameters such as soil, aspect, relief, and elevation and it is the interplay of all of these factors which determines the use of each of these communities by wildlife species, particularly ungulates.

Five different ungulate species have been documented to use the Whaleback study area to varying levels, including elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), moose (*alces*), and bighorn sheep *(Ovis canadensis*). None of the ungulates that occur in the Whaleback study area have been afforded any designation, either nationally or provincially, as requiring special management attention. However, all of these species are managed as big game animals and their continued viability is critical both commercially and ecologically. Numerous previously cited sources, in addition to Alberta Environmental Protection's *Wildlife Key Area Maps*, identify the Whaleback study area as providing critical habitats for elk, deer, and moose, while sheep habitat is also present in portions of the study area. Most of the Whaleback study area, however, is particularly noted for its provision of elk winter range.

Within the Whaleback study area itself, the diverse and heterogenous environments force some level of ecological separation among generally sympatric ungulate species, mainly due to different environmental preferences along biophysical gradients. Particularly important parameters include the degree of vegetative cover, forage type, structural stage, exposure, topography, and climate. Using such an environmental stratification to gauge ungulate distributions in the Whaleback, some broad trends become readily apparent. While elk and mule deer tend to congregate in the southern grasslands and are limited to higher elevation grasslands in the north part of the study

MAP 2 - WHALEBACK SIGNIFICANT FEATURES



area, moose occur largely in the northern end of the Whaleback study area where broad and damp valleys such as Bob and Black creeks have willow and dwarf birch communities.

Along with the Ya-Ha-Tinda - Panther area, the Livingstone-Whaleback area has long been considered one of the two most important elk winter ranges in the province (Bradley *et al.* 1977, O'Leary *et al.* 1989, Wallis 1994, AEP 1995). Both latitudinal and longitudinal location of the Whaleback has influenced its use by ungulates, particularly elk. Stelfox and Stelfox (1992) rate primary elk habitat in Alberta as occurring in the Rocky Mountain Natural Region (in both the montane and sub-alpine subregions), while they rate the majority of the Foothills Natural Region to the east as secondary habitat. Furthermore, southern habitats such as the Whaleback are influenced by chinooks, creating snow-free and south-facing grasslands with adjoining coniferous cover. Populations north of the Bow River have exhibited recent declines (Gunson 1992) due to a deterioration in range quality (forest succession) and relatively higher rates of predation, owing to a greater abundance of predators.

Gunson (1992) estimates a late-winter population of 12,840 elk on provincial lands and an additional 4,100 elk wintering in Waterton Lakes, Banff, Jasper, and Elk Island national parks. Historical elk population and management data are summarized for various regions in Alberta by Stelfox (1964), McFetridge (1985), and Smith (1985). Recent surveys conducted by Alberta Environmental Protection in an area including the Whaleback study area revealed fluctuating use of the area over the past few years (Table 2).

Elk distribution and habitat selection is determined by a combination of many factors including topography, vegetation structure, forage quality and quantity, traditional and habitual behavior, weather conditions, predators, and human activities (Morgantini and Russell 1983). Where winter ranges are concerned, snow-free areas are critical to winter survival of elk because they provide access to high quality forage in late-winter and early spring. Nietfeld *et al.* (1984) and Skovlin (1982) described snow depth as the factor most limiting to elk movement and distribution, as snow depths of 46 cm begin to restrict elk movement while depths of over 76 cm seriously limit their escape and foraging opportunities. The amount and extent of snow-free areas are dependent on snowfall, winter temperatures, chinook conditions, slope, and aspect. These factors contribute to the significance of the Whaleback study area as an elk wintering range which contains south-facing and southwest-facing wind-swept grassland slopes and ridges which are essentially snow-free throughout much of the winter.

Table 2: Elk Population Trend Counts for WMUs Encompassing the Whaleback Study Area

(from Clark 1995)

YEAR OF SURVEY	AREA (WMU)	
	A-7 / CHAIN LAKES (WMU 308)	OLDMAN (WMU 402)
1979-80	1151	27
1980-81	n/s [1]	n/s
1981-82	1377	54
1984-85	936	n/s
1985-86	1035	9
1986-87	676 [2]	65
1988-89	948	45
1989-90	1155	29
1992-93 [3]	984	22
1994-95	745	56

1. Not Surveyed
2. Poor Survey Conditions
3. A herd of approximately 100 elk which has traditionally wintered in WMU 308 in the vicinity of Chain Lakes is suspected to have moved east into WMU 304 during the winter of 1992/93.

In response to variable environmental conditions, elk exhibit two very different strategies in their habitat selection and subsequent movements. The first involves a year-round stationary home range while the other has developed into a migratory pattern linking winter, intermediate, and summer ranges together. The Whaleback study area is inhabited by both year-round resident elk populations and migratory populations which summer as far west as interior British Columbia. O'Leary *et al.* (1989) identified three primary wintering areas for elk in the Whaleback study area: (i) the area known locally as Sailor Jack Ridge (between Camp and Bob creeks); (ii) the unnamed ridges between Beaverdam and Coyote creeks; and (iii) the southern portion of the Whaleback ridge itself. Secondary wintering ranges were reported to include the headwaters of Beaverdam Creek along the west-facing slope of Whaleback ridge, the unnamed ridge between Coyote Creek and Eagle Coulee, and the ridge immediately east of Jackknife and Miles coulees.

In general, the main movement corridors for elk migrating to and from the Whaleback study area are along Deep Creek, along White Creek, and along the Oldman River through the Gap (O'Leary *et al.* 1989, AEP 1995). However, it should be noted that elk are not restricted to these corridors

for travel. Prevailing weather and snow conditions are the primary factors that dictate movement patterns. As a result, while valley bottoms of rivers and creeks are generally regarded as linear movement and dispersal corridors for large mammals, including elk in the Rocky Mountain east slopes of Alberta (Adams 1982, Morgantini and Russell 1983), Alberta Environmental Protection biologists in the region have noted that elk movement in the vicinity of the Whaleback study area is concentrated on ridge tops rather than in valley bottoms (R. Quinlan, personal communication).

Food habits of elk in Alberta have been extensively reviewed (see Morgantini and Russell 1983, Nietfeld 1983, Fargey 1988, Fargey and Hawley 1989, Stelfox *et al.* 1991, Renecker and Hudson 1992). These sources reveal that elk diets are extremely variable and largely dependent on local forage availability. While Kufeld (1973) found that 159 forbs, 59 grasses, and 95 shrubs have been reported as elk forage, grasses are the preferred forage for elk in Alberta throughout the year and are consumed in both succulent and dry seasons. Within the Whaleback study area, fescue, (*Festuca* spp.), bluegrass (*Poa* spp.), brome (*Bromus* spp.), wheatgrass (*Agropyron* spp.) and melic grass (*Melica* spp.) communities are all extensively utilized.

Key winter ranges for bighorn sheep are also present in the Whaleback study area, although the vast majority of critical sheep range in this region is located to the west of the Whaleback study area, on the Livingstone Range. The sub-alpine ridges found along Chaffen Ridge and Horseshoe Ridge, for example, do house some bighorn sheep over the winter seasons (R. Quinlan, personal communication). The open vegetation communities, relatively precipitous terrain, and extensive rock outcrops associated with these sub-alpine environments are important components of bighorn sheep habitats in the region. Local seasonal distribution of sheep in the Whaleback is dependent on a variety of factors including slope, distance to escape terrain, salt availability, elevation, aspect, forest cover, shrub productivity, biomass and nitrogen content of palatable grasses, and snow accumulation and cover.

In areas such as the Whaleback where winter ranges of numerous ungulate species overlap, elk can be serious competitors with bighorn sheep. Food habits of sheep and elk are similar in forage class composition throughout the year, although there are differences in actual species consumed (Table 3).

The geographic ranges of mule deer and white-tailed deer are sympatric in many regions of Alberta, including the Whaleback study area. While both species occur in the region, mule deer are significantly more abundant in southwestern Alberta while white-tailed deer tend to proliferate in the Parkland and Boreal Dry Mixedwood of central Alberta (Gunson 1989, Glasgow *et al.* 1995). The Alberta provincial government has divided the province into nine Deer Management Areas (DMAs), each representing a group of Wildlife Management Units with similar deer population characteristics. The Whaleback study area is a small component of parts of two DMAs, DMA #2 and DMA #3. Based on these delineations, DMA #2, which contains much of the eastern portion of the Whaleback, is estimated to have populations of 11,850 mule deer and 4,300 white-tailed deer. DMA #3, which contains the upper sub-alpine slopes of the Livingstone Range and

generally, the western portions of the Whaleback, is estimated to have 6,800 mule deer and 3,550 white-tailed deer.

Table 3: Preferred Forage Items Of Ungulates on Sub-alpine and Foothill Ranges in Alberta (adapted from Wishart 1958 and Etter 1972)

(H, M, and L represent High, Moderate, and Little or no utilization of the plant listed)

Plants Eaten	Bighorn Sheep	Elk	Mule Deer	Moose
Grasses				
Agropyron spp.	H	H	L	M
Koeleria cristata	H	M	L	L
Poa spp.	M	H	H	M
Bromus spp.	L	H	M	L
Sedges				
Carex spp.	H	M	M	M
Forbs				
Astragalus spp.	H	L	L	L
Oxytropis spp.	H	L	L	L
Hedysarum spp.	M	L	L	L
Delphinium spp.	M	L	L	L
Cirsium spp.	M	M	L	L
Shrubs and Trees				
Salix spp.	H	H	H	H
Populus tremuloides	H	H	M	H
Ribes spp.	H	L	L	L
Picea glauca	M	L	L	L
Rosa spp.	L	M	M	L

The Whaleback study area itself has been documented by provincial Wildlife Key Area Maps and other sources (for example, Bradley *et al.* 1977, AWA 1985) as providing critical mule deer winter range. Edwards (1974) reported that snow conditions, rather than snow depth, are largely responsible for high mule deer mortality in southern Alberta. High wind speeds and temperatures above freezing have been cited as factors leading to the formation of crusted or hard-packed snow

areas, effectively impeding movement and feeding ability. Thus, the very same factors which create snow-free areas that are attractive to elk also benefit mule deer.

Commonly noted as a species of the northern boreal forest, moose range extends south in Alberta along the forested front ranges of the Rocky Mountains. Moose populations in Alberta comprise a significant component of the province's native biota and are also managed as a renewable, marketable resource (Todd and Lynch 1992). The distribution of moose throughout their range is closely related to the range of northern trees and shrubs. They eat a variety of plants, ranging from mosses to tree bark, but this forage diversity is greatly reduced in winter when they must feed solely on woody browse that extends above the snow. Coady (1982) identifies the availability of these winter forage species as one of the major limiting factors of moose populations throughout their range.

Recent surveys conducted by Alberta Environmental Protection in February of 1996 in southwestern Alberta indicated a total moose population of 400 individuals in WMU 308 (R. Quinlan, personal communication, unpubl. data). Four different habitat types were surveyed during this recent effort, revealing density estimates of 3.6 moose / sq. km. in "shrubland" habitats, 0.9 moose / sq. km. in "deciduous forest" habitats, 0.8 moose / sq. km. in "mixedwood forest" habitats, and 0 moose / sq. km. in "coniferous forest" habitats in the vicinity of the Whaleback study area. The overall density estimate for WMU 308 was calculated to be 1.6 moose / sq. km., one of the highest reported moose densities in North America (Table 4).

Table 4: Moose Densities Reported From Various Areas of North America

Region	Density (moose / sq. km.)	Reference
Mackenzie River valley, Northwest Territories	0.05	Slaney (1974)
northeastern Minnesota	0.43 - 0.78	Peek *et al.* (1976)
Riding Mountain National Park, Manitoba	1	Carbyn (1977)
Saskatchewan (average, various surveys)	0.26 - 0.51	MacLennan (1974)
Sand River valley, Alberta	0.25 - 0.81	Usher (1977)
Kenai National Moose Range, Alaska	1.47	Evans *et al.* (1966)

The generalized shrubland habitats that AEP surveys revealed to contain an exceptionally high density of moose in the Whaleback study are essentially comprised of the following vegetation community types, identified in this project as subhygric aspen, low shrubland, willow thicket, willow shrubland, bog birch shrubland, and riparian types. Within the Whaleback study area, all of these communities provide habitats that are favored by moose. Throughout its range in North America, moose are associated with such sub-climax plant communities. Permanent communities of climax deciduous tree and shrub associations are found in the study area in the lower reaches of broad, meandering creek valleys such as Bob and Camp creeks. Winter food habits of moose have been reported extensively in the literature. A review of the major findings of these studies shows that willow (*Salix* spp.) are the primary food source for moose in western North America.

Large Carnivores

Carnivores are important indicators of ecosystem integrity in that they influence the structure, and reflect the vigor, of the trophic levels on which they depend. They are also generally sensitive to the abundance, distribution, and behavior of humans with which they coexist. Throughout much of the forested environment of western Canada, concern for the conservation of mammalian carnivores has centered on large species such as gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos*), and black bear (*Ursus americanus*). The ecological rationale for conserving these large predators includes the fact that they are often considered to be "umbrella" species. Foreman (1992), for example, speculates that by protecting habitat and landscape linkages for large predators, more than 90% of biodiversity will also be protected, including ungulate prey species. A preliminary analysis of niche overlap for 410 terrestrial vertebrates using the central Rockies of Canada indicates that protecting the habitat needs of grizzly bear, lynx (*Lynx rufus*), and wolves will conserve habitat for 403 additional species (Paquet and Hackman 1995).

Historically, large-scale extermination and loss of habitat have been the major threats to large carnivores throughout North America. Today, the most significant ecological threats to large carnivore survival are related to loss, alienation, and alteration of habitats resulting from anthropogenic sources. In many areas of North America, particularly in the Rocky Mountains (Paquet and Hackman 1995), these human activities have proven to contribute to the fragmentation of the landscape, effectively blocking dispersal corridors and creating impediments to inter-territorial and intra-territorial movements. The Whaleback study area, however, is characterized by largely undisturbed and relatively intact wilderness amidst a complex of other more disturbed landscapes. Many large, vagile carnivores are able to persist in the vicinity of the Whaleback study area, which may house one of the most diverse assemblages of large carnivores of any landscape in North America. A total of eight large carnivore species - gray wolf, coyote (*Canis latrans*), black bear, grizzly bear, wolverine (*Gulo gulo*), cougar, lynx (*Lynx canadensis*), and bobcat (*Lynx rufus*) - inhabit the study area at varying levels of abundance. In addition to these 'larger' predators are other related carnivores such as red fox (*Vulpes vulpes*) and numerous mustelids, which are further detailed in the next section.

While a few protected areas (Waterton Lakes National Park, Kootenay National Park, Peter Lougheed Provincial Park) are also present in close proximity to the Whaleback study area, these refuges account for only a small percentage of the area used by large carnivores to fulfil their biological needs (Picton 1979). The minimum habitat requirements for most large, far-ranging carnivores are not adequately met by existing parks, thus emphasizing the significance of adjacent wilderness areas such as the Whaleback.

Wallis (1980, 1994) and AEP (1995) have cited the significance of appropriate habitats in the Whaleback study area for grizzly bears. In describing the nature of the Whaleback study area as *"connected to adjacent wildlands and ...essentially unfragmented"*, AEP (1995) has described natural values that are required, but becoming increasingly scarce, for grizzlies in southwestern Alberta. Among Alberta's resident large carnivores, the grizzly bear is most often used as a measure of ecosystem health and has been cited by Hamer and Herrero (1983) as a species that is experiencing declining populations in the southern Canadian Rocky Mountains. Characterized by an intrinsically low population density, low reproductive output, and a general incompatibility with anthropogenic activity, grizzly bears have been rendered sensitive to various levels of development and habitat fragmentation.

The status of grizzly bears in Canada was re-examined by COSEWIC in 1991 (Banci 1991) and most populations of grizzlies, including those in Alberta, were classified as *"vulnerable"*. Within Alberta, populations in the west-central foothills, sub-alpine mountainous ranges of the northern Rocky Mountains, and the southern foothills and Rocky Mountains currently occupy 64, 54, and 83 percent of their potential habitat capabilities, respectively (Banci 1991). In Alberta, AEP (1996) has designated the grizzly bear as a blue-listed species of concern, despite *"numbers that have remained relatively stable outside the national parks"*. The loss and fragmentation of wilderness habitat is widely acknowledged as the greatest threat to grizzly bears both in Alberta and throughout their range (Horejsi 1986, Gunson and Treichel 1987, Lefranc *et al.* 1987, Nagy and Gunson 1990, McLellan 1992, AEP 1996).

Grizzly bears are opportunistic omnivores that feed on a variety of plant and animal items, many of which are only available seasonally. As a result, the annual feeding cycle of grizzly bears follows plant phenological patterns which are, in turn, related to temperature and elevation; grizzlies are altitudinal migrants whose movements are driven by attempts to maximize energy values in preparation for a torpid winter state. Throughout much of the grizzly bear's range in Canada, herbaceous vegetation such as horsetails (*Equisetum* spp.), sedges (*Carex* spp.), and grasses as well as non-native clovers (*Trifolium* spp.) are important early summer forage items while feeding activity switches to berries such as *Shepherdia* spp., *Vaccinium* spp., and *Arctostaphylos* spp. in late summer and fall. Given the diversity and distribution of vegetation community types in the Whaleback study area (see Section 4.1), general grizzly bear foraging activity in this region likely conform to this pattern, which is typical of most east-slope grizzly bears.

However, the presence of relatively rare whitebark pine ecosystems in sub-alpine environments such as those found atop Chaffen Ridge and Horseshoe Ridge provide an additional unique resource for bears, both grizzly and black. Ogilvie (1990) describes whitebark pine as an upper sub-alpine forest occurring most abundantly at timberline, where it grows with Engelmann spruce and subalpine fir. Thus, the range of whitebark pine in Canada is limited to the mountain ranges of interior and coastal British Columbia and western Alberta. Seeds of these whitebark pine trees are considered high quality food items for bears for numerous reasons, as summarized by Mattson and Jonkel (1990):

1. The seeds of whitebark pine and other stone pines (subsection *Cembrae*) are characterized by high triacerglycerol content and energy concentrations comparable to that of fleshy fruits.
2. Stone pine seeds mature by August and are available from then until bears hibernate. This period corresponds with the critical hyperphagic state during which bears accumulate the fat necessary to sustain them through hibernation and subsequent hypophaegia.
3. Because of their high digestible lipid content, whitebark pine seeds likely contribute more to efficiencies of body fat accumulation by bears than do foods high in protein or sugar content.
4. Because of their durable nature, pine seeds can overwinter in or out of cones and provide high quality food for bears the next spring and summer.

Within its North American range, whitebark pine is considered by many to be abundant only south of the Canadian border (in the cordillera of the western United States) and, farther north, is considered only an incidental part of the forest vegetation (Arno and Hoff 1989, Ogilvie 1990). Nonetheless, the potential significance of these whitebark pine communities to bears in the Whaleback study area is emphasized by the fact that whitebark pine is used by bears wherever it is abundant. Additionally, studies have shown that, when feeding on whitebark pine seeds, bears tend to consume the seeds to the near-exclusion of all other foods. Within the Whaleback study area, whitebark pine occurs at high elevation in the Sub-Alpine Natural Subregion, often at the transition between the False azalea/grouseberry (eSA) forest ecosite and Rough fescue/hairy wild rye - awnless brome communities beginning at approximately 1600 masl.

While grizzly bears have been recorded in the Whaleback study area (R. Quinlan, personal communication; also, see records of observations in Wallis 1980, 1994) and adjacent areas to the north, south, and west are considered significant grizzly bear habitat, the actual extent of grizzly bear habitats and use within the Whaleback study area remains unclear, if only due to a lack of quantitative data. If, however, the Whaleback is considered a significant habitat component for regional grizzly bear populations, their relationship with vegetation communities, including upper sub-alpine whitebark pine forests, needs to be further elucidated.

Most of the upper subalpine and some montane environments within the Whaleback study area are also significant for wolverines, which occur in the vicinity of the Whaleback at the extreme eastern limit of their southern Alberta range. Wolverine are the largest terrestrial members of the Mustelidae and their historic distribution included almost the entire North American continent in the early settlement period. While the present distribution of wolverine is almost half of its historical distribution, the majority of range restriction has been witnessed in the southern United States; the species' range throughout most of the forested and alpine areas of western Canada remains largely intact.

The Alberta population of wolverines is considered a segment of the western Canadian population, which has been designated as a nationally *"vulnerable"* species by COSEWIC since 1989 (COSEWIC 1996). In Alberta, the provincial Wildlife Management Division manages the wolverine as a blue-listed species (AEP 1996), however knowledge of the current population status and population trend are speculative at best. Of all the wildlife species for which biological information is lacking, the wolverine is perhaps the most unknown. It has been classified as one of North America's rarest mammals and least known large carnivore. Banci (1994) reported wolverine to live at very low densities even under optimal habitat conditions. Although wolverine range throughout much of western and northern Canada, very little is known about this elusive species anywhere in its range. Only four North American field studies on wolverine have been completed to date; two in Alaska (Gardner 1985, Magoun 1985) and one each in the Yukon Territory (Banci 1987) and Montana (Hornocker and Hash 1981). The paucity of information is largely due to the difficulty and expense of studying a solitary, secretive animal that is rare compared other carnivores, and is usually found in remote places.

One of the most significant components of the large carnivore assemblage in the Whaleback study area is its cougar population. The Whaleback and adjacent Livingstone Range and Porcupine Hills regions have been identified as having one of the highest densities of cougar populations in Alberta (Jalkotzy *et al.* 1992, Wallis 1994, AEP 1995). While the western population of cougar are not afforded a formal federal designation by COSEWIC, the species in Alberta is managed as a yellow-listed species (AEP 1996) with populations appearing to be stable at approximately 600 individuals outside the national parks. Owing to the possible extirpation of eastern populations of cougars and severe range reduction of western populations, the provinces of Alberta and British Columbia are now thought to harbor virtually the entire population of cougar in Canada (Paquet and Hackman 1995).

In Alberta, the cougar's range is limited largely to mountain and foothill habitats of the Rocky Mountains in the southwestern portion of the province, although occasional extralimital sightings have been reported from the Cypress Hills, Milk River and South Saskatchewan River drainages east of the mountains, and Wood Buffalo National Park (Jalkotzy *et al.* 1992). Within their Alberta range, the most productive cougar habitat is found in the extreme southwest of the province. Provincial Wildlife Management Units 300, 302, 304, 305, 308, 310, and 312 extending north from the United States border each have estimated densities of 4.0 cougars / 100 km^2. The Whaleback

study area is located along the western edge of this conglomeration of WMUs, encompassing portions of WMUs 402 and 308. Jalkotzy *et al.* (1992) reports the area south of the Bow River as including only 15 percent of all cougar habitat on provincial lands yet this area has an estimated population of 385 cougars, or 61 percent of the total population on provincial lands.

The Whaleback study area provides habitat conditions that are well-suited to allow the persistence of viable populations of cougars. Cougars have been shown, for example, to compete directly with wolves where the two species are sympatric (White and Boyd 1989, Paquet 1993). Although cougar and wolves do occur sympatrically in the Whaleback study area, wolves are generally considered to be more scarce in southern Alberta than in northern portions of the province, while cougar populations show an opposite trend, being more abundant in the south and scarcer in the north. The mechanisms of competitive exclusion between wolves and cougars is not fully understood, however it likely related to the differences in ungulate distribution between northern and southern portions of the cougar's range in Alberta. While moose densities are higher in the central and northern parts of cougar range in Alberta (thus attracting wolf populations), better deer and elk habitat, milder winters, and lesser snow accumulations result in higher deer and elk densities in the south. This trend favors increased cougar densities in the south, as cervids (particularly mule deer) are by far the most prevalent and preferred prey item of cougars. The significant number of ungulates that winter in the Whaleback study area itself are of numbers sufficient to sustain cougar populations. Most researchers agree that, in general, the protection, management, and enhancement of deer populations and deer habitat are important components of any strategy designed to conserve and manage cougars (Hornocker 1970, Spreadbury 1988, Quigley *et al.* 1990, Ross and Jalkotzy 1992, Paquet and Hackman 1995).

Small Forest Carnivores

A group of mammals that gets considerably less attention than the large, charismatic, *'mega-carnivores'* are a suite of smaller but no less significant carnivores that are often referred to as "furbearers". Use of the term "furbearer" can be deceiving, however, because wolves, lynx, and black bear are also managed provincially as commercially valuable fur commodities but are regarded as "large carnivores" by ecologists who refrain from using terms which reflect a utilitarian value. The suite of smaller carnivores with which we are dealing in this section is comprised mostly of the mustelids, or weasels. In particular, marten (*Martes americana*) are one of the species which occur in the Whaleback study area at the periphery of its range in Alberta.

Due largely to their economic importance, species such as marten have been the subject of numerous habitat-oriented studies. In addition, there has recently been a renewed interest in the species as an indicator of the long-term health of boreal forest ecosystems (Buskirk 1992). Marten occupy a narrow range of habitat types and occur in the Whaleback study area at the eastern limit of their range in southern Alberta. The geographic distribution of marten through

southern Alberta and into the United States is limited to extensions along cordilleran mountain ranges.

Marten associate closely with late-successional stands of mesic conifers, especially those with complex physical structure near the ground (Buskirk and Powell 1994). They prefer stands with various age and size classes because they provide a greater diversity and abundance of foraging areas and protective cover than do even-aged stands. Marten are opportunistic predators and will feed on a variety of small animals that are fairly common and abundant in boreal forested habitats, including red squirrel (*Tamiasciurus hudsonicus*), red-backed vole (*Clethrionomys gapperi*), northern flying squirrel (*Glaucomys sabrinus*), snowshoe hare (*Lepus americanus*), and numerous other small mammals and birds. All of these prey species, in addition to marten themselves, are representatives of the Boreal-Cordilleran faunal element and are, thus, more abundant in northern boreal habitats of Alberta than in the higher elevation montane forests of the Whaleback study area.

Small Terrestrial Mammals

In natural habitats, vegetative complexity and habitat size are major determinants of the abundance of small mammal species and of the structure of mammalian communities. Recent studies conducted in the mixedwood forests of northern Alberta also echo the view that mammal species richness and abundance in mixedwood forests reflect the structural complexity of the forest (Roy *et al.* 1995). Roy *et al.* observed that structurally complex old stands (greater than 120 years old) supported more species than did structurally simple mature stands (aged 50-65 years) or young stands (aged 20-30 years) that were intermediate in structural complexity.

Among the small, terrestrial mammals within the Whaleback study area are included seven species of ground squirrels, marmots, and chipmunks, some with affinities to mountainous Cordilleran faunal elements (e.g., golden-mantled ground squirrel [*Spermophilus lateralis*]) and others with affinities to grasslands of the east (e.g., Richardson's ground squirrel [*Spermophilus richardsoni*]). Also found at varying levels of abundance in the vicinity are two species of tree squirrels - the red squirrel (*Tamiasciurus hudsonicus*) and the northern flying squirrel (*Glaucomys sabrinus*) as well as seven species of microtine rodents, including peripherals such as the sagebrush vole (*Lagurus curtatus*), typically considered as having Campestrian affinities to grassland habitats of southern Alberta.

While none of the small, terrestrial mammals found in the Whaleback study area are federally listed as imperiled, four of them - the hoary marmot (*Marmota caligata*), Richardson's ground squirrel, northern flying squirrel, and water vole (*Microtus richardsoni*) - are managed as yellow-listed species in Alberta (AEP 1996). In addition, the significance of some of the region's small mammals may lie in the role they play in the functioning of local ecosystems; such species may be either controller and/or keystone species. *Controller species* are species which play major roles in

controlling the movement of energy and nutrients. *Keystone species* are those which play ecological roles that are of greater value than one would predict based on their abundance alone. Since most members of these species groups are small and relatively sedentary, they have the potential to drastically affect any ecosystem component within which they stay for extended periods. One such species in the Whaleback is the red squirrel, which can be considered both a controller and a keystone species in the region.

Red squirrels are widely distributed in Alberta, occurring primarily in association with mature coniferous forests. They subsist on conifer seeds and buds, and Rusch and Reeder (1978) indicate that population densities and annual survival rates are highest in spruce forests and lowest in aspen forests. Therefore, mature white spruce or Engelmann spruce stands are considered to provide optimum habitat for red squirrels in the Whaleback study area, however other forest types such as those dominated by pines are also used extensively, depending on availability. In the Porcupine Hills, adjacent and to the east of the Whaleback study area, Fairbarns (1989) reported red squirrels to be abundant in spruce - Douglas fir, lodgepole pine - subalpine fir, and poplar / showy aster - hairy wild rye forest types but to be conspicuously absent from limber pine forest types.

In numerous areas where whitebark pine occurs (primarily in the cordillera of the western United States), red squirrels have been shown to play a significant role as an intermediary between grizzly bears and whitebark pine. Hutchins and Lanner (1982) reported the large, edible seeds of whitebark pine to be preferred over the seeds of other conifers, however, red squirrel use of pure whitebark pine forests in the Whaleback study area may be hampered and/or limited by (i) the highly variable cone crops characteristic of whitebark pine and (ii) the high, cold, and harsh environment associated with most of these stands.

While grizzly bear use of whitebark pine forests in the Whaleback study area is not clear at this time, in most other areas where grizzly bears make substantial use of pine cone seeds, red squirrels are a critical link, particularly in the Rocky Mountains where they have been shown to preferentially harvest whitebark pine and limber pine seeds (Hutchins and Lanner 1982) and cache them in middens. Rodents such as red squirrels (and sometimes chipmunks) increase the foraging efficiencies for bears by harvesting otherwise unavailable, intact cones and seeds from trees and concentrating them in caches. Grizzly bears have been shown to search out these caches and feed on the whitebark pine cones and have also been shown to benefit from the fidelity to midden sites displayed by red squirrels from year to year. In the area of Yellowstone National Park, for example, Kendall (1983) noted that individual squirrel middens were repeatedly visited and searched by bears in the same and different years.

Among the species that occur in the Whaleback study area at the western periphery of their range both in Alberta and in Canada is the sagebrush vole. In Canada, the sagebrush vole is found only in southwestern Saskatchewan and most of southern Alberta. Salt and Wershler (1975) reported the capture of a sagebrush vole from the Whaleback area, resulting in a distributional and elevational range extension for the species. Throughout the range of the sagebrush vole,

population estimates and habitat characterizations are generally considered inadequate to assess the status of the species, expounded by the fact that the species has been federally recommended for "indeterminate" status by COSEWIC (Cobb and Morissette 1996) and listed as "status undetermined" in Alberta (AEP 1996).

General habitat requirements of the sagebrush vole include semi-arid prairies, rolling hills, and brushy canyons with loose, well-drained soil and adequate cover. In Canada, Banfield (1981) describes the species as being restricted to native-mixed grass habitats, although detailed habitat preferences appear to be unclear at this time. Vegetation of sagebrush vole habitats is traditionally typified by silver sage (*Artemisia cana*) communities, which are not a dominant community in the Whaleback study area. However, Salt and Wershler (1975) reported sagebrush voles from the upper elevation limber pine / Douglas fir communities within the Whaleback montane. Field work conducted for this project in the summer of 1996 showed that these communities are typified by having dry, grassy ridge tops where a sparse but diverse ground cover of grasses includes fescues (*Festuca* spp.), bluegrasses (*Poa* spp.), bromes (*Bromus* spp.), wheat grasses (*Agropyron* spp.), and oat grasses (*Danthonia* spp.). Other montane grassland community types in the Whaleback study area, as described previously in section 4.1, also include needle grass (*Stipa* spp.) and hairy wild rye (*Elymus innovatus*) types.

A sharp decline in available prairie grassland habitats in Alberta, as reported by Environment Canada (1991), is a major concern for wildlife species, such as the sagebrush vole, which are dependent on these threatened habitats. It is currently estimated that less than 24% of mixed grass and rough fescue prairie remains undisturbed and that only 1-5% of original plains fescue habitat presently exists. As a result, the potential colonization of montane grasslands in areas such as the Whaleback, which intergrade with adjacent foothill and prairie grasslands, may be a crucial step for the continued viability of grassland-dependent species.

Semi-Aquatic Mammals

Mammals that inhabit wetlands and aquatic habitats exhibit specific traits that make them highly vulnerable to isolation and habitat fragmentation. Virtually every species of North American mammal weighing more than 0.5 kg that inhabits wetlands is commercially valuable as a furbearing animal (Harris 1988). Of these semi-aquatic mammals, those that are carnivorous (either carnivores in the strict sense or omnivorous members of the order *Carnivora*) have larger home ranges than the herbivores of equal size and, because they inhabit the water and the water's edge, their home ranges tend to be long and narrow, aggravating the probability of fatal encounters with human activity. With this in mind, two species of semi-aquatic mammals are prevalent in the Whaleback study area: the strictly herbivorous beaver (*Castor canadensis*) and the largely carnivorous mink (*Mustela vison*).

Based on observations collected during field work in the summer of 1996, beaver activity in the Whaleback study area was noted to be quite high. The structural heterogeneity of these beaver ponds is significantly higher than that found in surrounding terrestrial habitats. The benefits to other wildlife species derived from the alteration of aquatic habitats by beavers have been well documented (Reese and Hair 1976, Hill 1982, Avery 1983, Reid 1984, Ringelman 1991). Within the Whaleback study area itself, trumpeter swans have been documented utilizing beaver impounded wetlands in the vicinity of Cow Juicer Pass[2] (D. McIntyre, personal communication). The activities of beaver increase general habitat diversity by opening the forest canopy, creating standing water, creating in-stream cover in the form of woody debris, and increasing habitat edge.

The distribution of beaver in the Whaleback study area is influenced by numerous factors including topography, slope, vegetation quality and quantity, and, of course, water availability. In areas where general topographic requirements are met, food availability is the most important biotic constraint to beaver distribution. Although herbaceous upland vegetation may sometimes receive extensive use as food by beavers in spring and summer, deciduous trees and shrubs constitute the main source of food. Aspen and willow are generally the preferred forage, although both balsam poplar and birch are also used extensively where they are locally abundant. The creek valleys of all major watercourses in the Whaleback study area are used extensively by beavers. Beaver activity is particularly prevalent along White, Camp, Bob, Beaverdam, and Coyote creeks and is also found on stretches of the Oldman and Livingstone rivers. As a matter of fact, one of the tributaries (from the south) to White Creek has been impounded and utilized so significantly by beavers that it has created one of the largest wetlands in the Whaleback study area.

Mink are one of the most widespread carnivores in North America. Populations of mink are reported by AEP (1996) to be generally stable and healthy, occurring throughout appropriate range wherever water margins with good prey availability are present. In the Whaleback study area, mink are found in association with stream and river banks and wetland margins; they are quite common along most stretches of the Oldman and Livingstone rivers.

The availability of suitable denning sites may be a primary limiting factor for mink in Alberta. Mink typically select den sites that are close to preferred foraging areas or concentrations of prey items and they use several dens within a single home range for concealment, shelter, and litter rearing. Inter-den movements are most often made in, or along, linear habitat features such as river banks or stream margins (Birks and Linn 1982). A full complement of structural features are also required within these riparian ecosystems, as Racey and Euler (1983) and other authors have shown that deadfall, stumps, windthrown tree roots, and other such "natural cavities" are most

[2] Trumpeter swans are known to utilize appropriate wetland habitats in the Whaleback study area during vernal and diurnal migrations. However, Alberta Environmental Protection (Wildlife Management Division) report that there are currently NO known nesting records of trumpeter swans within the study area (R. Quinlan, personal communication).

often selected as den sites. Given this data, appropriate habitat for mink in the Whaleback study area is most likely to be found in association with the upper to middle reaches of the Oldman and Livingstone rivers and in higher ordered tributary streams such as White Creek (see Appendix G, Plate 14).

4.3.2.3 Herptiles

Amphibians and reptiles are often abundant elements in most terrestrial and many freshwater ecosystems and, therefore, constitute a significant component of the world's biodiversity. However, Bishop and Petit (1992) and numerous other researchers recognize that there is currently a dearth of knowledge about the health and stability of most populations of amphibians and reptiles worldwide. Despite this paucity, most authors also acknowledge recent global declines in amphibian populations (Barinaga 1990, Blaustein and Wake 1990). As a group, herptiles are also acknowledged as one of the most endangered groups of organisms in southern Canada (WWFC 1988, Quinn 1991). Causes for declines, both globally and in North America, that have been proposed by Seburn (1993) include acid precipitation, airborne pesticides, and ultraviolet light. Clearly, habitat degradation should be added to this list, as losses caused by agricultural activities are major causative factors associated with declining biodiversity.

The herpetofaunal assemblage of Alberta is generally not regarded as being extensive, with the greatest concentration of species occurring in the arid southeastern corner of the province. A total of eight species of reptile and 10 species of amphibians are known to occur in Alberta but geographic ranges described by Russell and Bauer (1993) indicate that only six species - tiger salamander (*Ambystoma tigrinum*), boreal toad (*Bufo boreas*), spotted frog (*Rana pretiosa*), wood frog (*Rana sylvatica*), wandering garter snake (*Thamnophis elegans*), and red-sided garter snake (*Thamnophis sirtalis*) - potentially occur in the Whaleback study area. The lack of appropriate wetland habitats over much of the study area is the primary limitation for herptiles in southwestern Alberta.

4.3.2.4 Fish

Species diversity of fishes, as with terrestrial wildlife, is dependent on the provision of diverse, heterogeneous habitats. Such habitat heterogeneity can be provided by both vertical stratification of habitats in deep lakes and through horizontal stratification of habitats along a stream gradient. Thus, fish habitat in the study area is limited for the most part to the region's major drainage feature, the Oldman River. Generally, the number of fish species is greater downstream than upstream. Since the Whaleback study area encompasses the upper reaches of the Oldman River, the shifts in physical gradients along the river are abrupt and there are very narrow transition zones; species diversity of fishes is accordingly low. Ten species of fish are anticipated

to inhabit appropriate lotic and lentic habitats in the study area: mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*), cutthroat trout (*Salmo clarki*), rainbow trout (*Salmo gairdneri*), longnose dace (*Rhinichthys cataractae*), lake chub (*Couesius plumbeus*), fathead minnow (*Pimephales promelas*), longnose sucker (*Catostomus catostomus*), mountain sucker (*Catostomus platyrhynchus*), and trout-perch (*Percopsis omiscomaycus*). Over-wintering of fish populations in the Whaleback study area is provided only in deep pools within the Oldman and Livingstone rivers, while smaller stream habitats in tributaries to the both the Oldman and the Livingstone are often extremely critical for spawning and reproduction.

Neither the federal list of vulnerable, threatened, or endangered species (COSEWIC 1996) nor the provincial Wildlife Act of Alberta recognizes any Rocky Mountain east slopes fish species to be in an imperiled state. However, most significant among the Whaleback's fish species assemblage are the bull and cutthroat trout salmonid populations. The bull trout is the most actively managed fish species in Alberta and, although it is currently not afforded any protective designation, it is widely acknowledged that there has been a significant decline in the species' distribution and population throughout its North American range over the past 25-30 years (Boag 1987, Roberts 1987, AFWD 1990, Rieman and McIntyre 1993). The bull trout, or bull char, is indigenous to east slopes streams of the Rocky Mountains, extending from the South Saskatchewan River drainage in the south to the Peace River in the north (Nelson and Paetz 1992). Within the Whaleback study area, numerous sources have identified bull trout as occurring in the Oldman River and in Bob Creek (Bradley *et al.* 1977, AWA 1986, AEP 1995). Due largely to overfishing and the impoundment of east slopes watercourses, the bull trout is now rare or extirpated from much of its former range in the downstream reaches of rivers.

Bentz *et al.* (1995) reported that numerous lower and middle order streams house a seemingly abundant population of bull trout in the Foothills Natural Region of Alberta, but also warned that the protection of these habitats are critical to ensure the future recolonization of downstream habitats. Roberts (1991) states that *"there is already sufficient evidence that prairie populations of the Bull Trout are clearly endangered"* and that recolonization sources for these fishes are present only in upstream reaches of foothill and subalpine streams (such as Bob and Camp creeks and the Oldman River). AFWD (1990) reports that the species is *"not in immediate danger of extinction but could easily disappear from some of our lakes and streams. Many populations are unable to maintain current numbers and will continue to diminish unless properly managed."*

Biological data concerning the ecological requirements of bull trout are relatively scarce in the literature due to the fact that the species has only recently been taxonomically differentiated from the coastal dolly varden (*Salvelinus malma*); prior to 1978, bull trout were generally considered to be conspecific with dolly varden. Bull trout are thought to have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993), with temperatures in excess of 15-18°C consistently listed by researchers as a factor limiting bull trout distribution in Alberta and throughout its range (D.A. Westworth and Associates Ltd. 1992, Newbury and Gaboury 1993). Generally, stream channel complexity is also regarded as an important component of the natural

environment for viable populations of bull trout. Bull trout usually associate with complex forms of cover. Juveniles live close to in-channel wood, substrate, or undercut banks; young-of-the-year use side channels, stream margins, and other areas of low velocity flow; and older fish utilize pools and areas with large or complex woody debris (Pratt 1992). Cover is especially important in providing overwintering sites and is thought to limit many fish populations. A combination of unique habitat requirements and intrinsic biological constraints can be identified as being the primary limiting factors to bull trout in upper stream reaches, as follows:

1. Bull trout require cold, clean, groundwater-fed streams; such high altitude headwaters are areally limited in Alberta.
2. Spawning and nursery streams are cold and small, providing very little in the way of food, space, and shelter. These stream characteristics limit the number of fingerlings that can be supported, even after successful spawning.
3. Overwintering occurs in deep pools or in association with large woody debris, both structural features which are limited in number and capable of supporting only a small number of fish.
4. Reproductive potential of bull trout is naturally low and the fish mature slowly, often reaching spawning age in their fifth or sixth year. In addition, some female bull trout do not spawn in consecutive years.

Bull trout are currently managed as a sportfish in Alberta and existing sportfishing regulations enforce a province-wide catch limit of two. However, recent concerns over the provincial status of bull trout has resulted in reconsideration of the species' management and potential designation as a species of special concern. In an attempt to further the understanding and recognition of the species, a provincial Bull Trout Task Force has been organized and a *Bull Trout Management and Recovery Plan* (Berry 1994) prepared. Included in that document are considerations to reduce the catch limit to zero and to enforce seasonal, permanent, and all-year closures above and beyond those already in place.

Cutthroat trout are also a commercially and recreationally significant fish resource occurring in the Whaleback study area. Nelson and Paetz (1992) report that *"stream fishing for cutthroat is restricted to upper reaches of mountain streams such as the tributaries to the Castle, Oldman, and Highwood rivers... and in lakes of Banff National Park."* Two widespread forms of cutthroat trout are recognized in Canada. The coastal form, *S. c. clarki* occurs along much of the western coast while the interior form, *S. c. lewisi*, or the Yellowstone cutthroat, occurs in southeastern British Columbia and southwestern Alberta and south into Colorado and Utah. Nelson and Paetz (1992) report that due to fish cultural activities and natural and induced hybridization with rainbow trout, there are few native populations of cutthroat trout left in Alberta.

Cutthroat trout are generally regarded as spring spawners. However, the actual time of spawning is dependent on a variety of environmental factors, including water temperature, runoff volume and velocity, ice melt, elevation, and latitude. As a result, trout populations in the Whaleback study area are likely to spawn later in the spring and into the early summer season. The cutthroats of the interior mountain slopes can be classified as one of three life history forms - adfluvial, fluvial, or resident. Adfluvial fish live in large lakes and spawn in lake tributaries. Such habitat (large, deep lakes) is limited in the Whaleback study area and, as a result, it is unlikely that trout in the area are adfluvial. Most trout in the area are more likely to be fluvial fish, living and growing in rivers rather than in lakes but they too immigrate to tributaries for spawning. Resident fish complete their entire life span in tributaries but they are typically quite small, seldom exceeding 300 mm in length.

Optimal cutthroat trout riverine habitat is characterized by clear, cold water; a silt-free rocky substrate in riffle-run areas; an approximately 1:1 pool-riffle ratio with areas of slow, deep water; well-vegetated stream banks; abundant in-stream cover; and relatively stable water flows and temperature regimes (Raleigh and Duff 1981). As is the case for bull trout, cover is recognized as one of the essential habitat components for cutthroat trout as well. Submerged vegetation, undercut banks, and in-stream objects such as brush or debris piles, logs, and large rocks constitute important cover habitat that is used for overwintering and for predator avoidance and resting in the summer. For inland trout species which do not exhibit patterns of anadromy, the amount of available overwintering habitat, rather than spring spawning and summer rearing habitat, has been cited as the major factor limiting fish densities.

While cutthroat trout may be found throughout the large river basins in and around the Whaleback study area (specifically, the Oldman, Livingstone, and Crowsnest rivers), spawning and early rearing occurs mostly in headwater and low order streams such as Racehorse, Vicary, and Dutch creeks. As a result, management of cutthroat trout and associated species (including bull trout) will require a consideration of the species' habitat across landscapes rather than at the microhabitat scale, as has been the predominant case in the recent past. Although it is at this time unclear how strongly habitat variability influences trout populations, a logical consequence of such variability is that natural selective processes should tend to produce adaptations to local environments. Leary *et al.* (1985), Marnell (1988), Rieman and Apperson (1989), and Young (1995) all present indirect evidence of local adaptation, thus supporting the theory that individual populations exist as self-perpetuating parts of a larger regional population.

The range and diversity of aquatic environments that these salmonid species inhabit throughout their life history combine to make them vulnerable to environmental perturbations. Water diversions, irrigation projects, livestock grazing, timber harvesting, and associated road and trail construction are among the most predominant land use activities which affect aquatic environments in Alberta. Furthermore, these impacts can accumulate from adjacent riparian areas rather than originating from the stream channel itself. The construction of roads and stream crossings, for example, can modify natural drainage networks and accelerate erosion processes. These changes can alter physical processes in rivers, leading to changes in streamflow regimes,

sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to the River. Subsequently, such changes can have important biological consequences for fish species which utilize stream habitats to provide food, shelter, spawning substrate, suitable water quality, and access for migration both upstream and downstream.

Chilibeck *et al.* (1992) have identified a *Fisheries Sensitive Zone* which extends much further than the wetted boundaries of any given stream or river. The recognition of critical fish habitats that incorporate such broad impact zones and buffer areas must be completed at a much larger scale and more detailed scale than this project will allow. However, the recognition of the Oldman River as a significant trout-bearing stream will aid in directing future inventory and assessment at local planning levels.

4.3.3 Checklists of Significant Areas

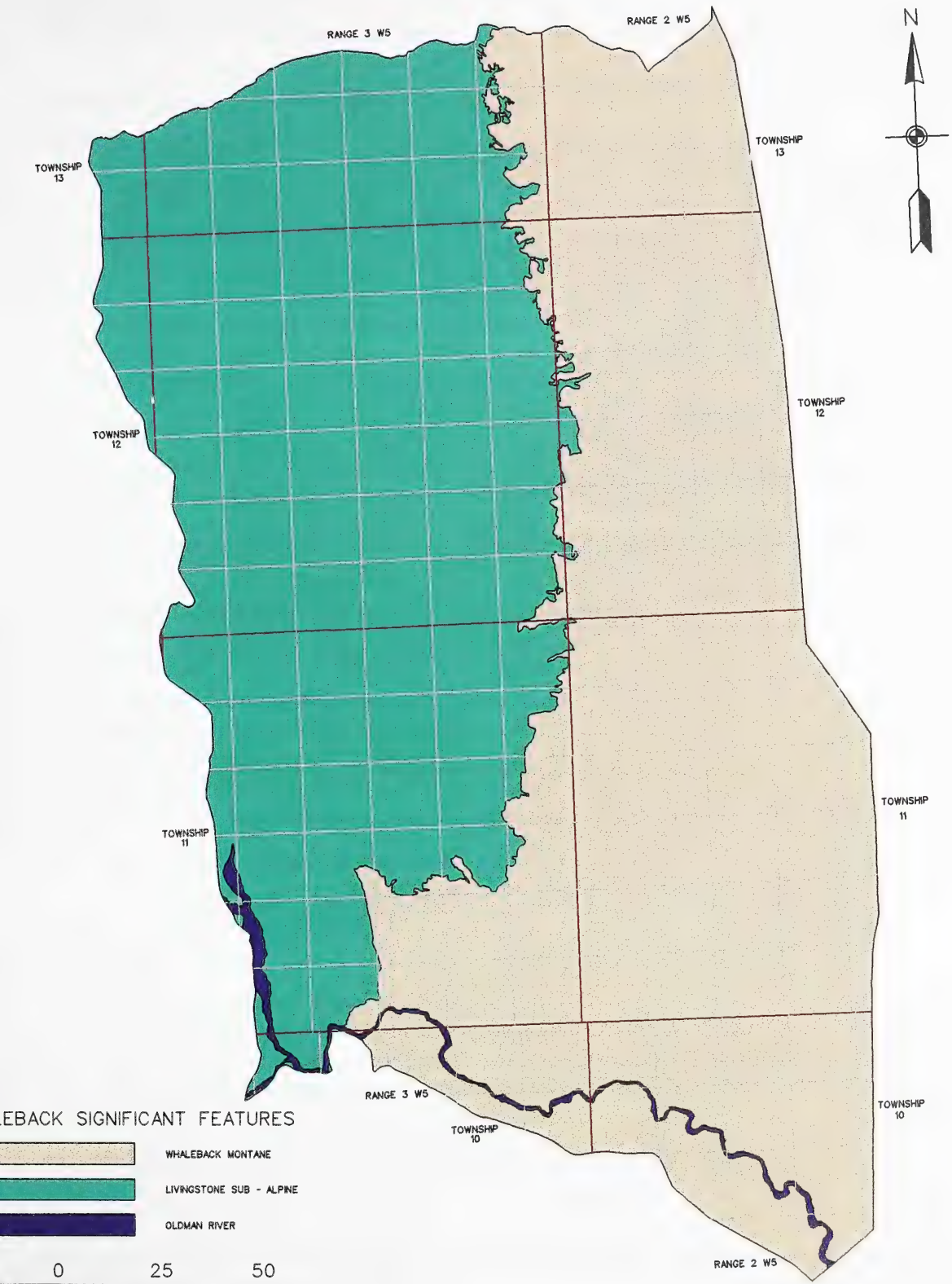
Numerous studies have identified many significant and special features within the Whaleback study area (Alberta Environmental Protection 1995, Wallis 1994 and 1980, Downing and Karpuk 1994, Cottonwood Consultants Ltd. 1987, Bradley et al. 1977). The reader is referred to these sources for specific information.

An underlying implication of the results presented in the above studies is that the Whaleback study area can be considered, from a landscape perspective, to consist of three generalized significant areas, each of which possesses many special and significant features. Generalizing the Whaleback study area into three broad-based significant areas acknowledges the inter-dependence of the many features identified in previous studies, by which each feature serves to support or enhance the ecological importance of the others within the landscape. Similarly, and again from a landscape perspective, each generalized significant area serves to enhance the ecological importance of the others and, when all are considered in total, encompasses a relatively undisturbed wilderness area of very high ecological significance. The three significant areas within the Whaleback study area as identified and delineated during the present study are:

- **Whaleback Montane**
- **Livingstone Sub-Alpine**
- **Oldman River**

The following are descriptions or checklists of the three significant areas. Locations of these areas are presented on Map 2 (following page). The significant areas checklists are grouped by level of significance, from national to provincial significance.

MAP 2 - WHALEBACK SIGNIFICANT FEATURES



Area Name: **Whaleback Montane**

Description:

- the unit encompasses those portions of the study area north of the Oldman River which lie within the Montane Subregion, and generally includes southern, central and eastern portions of the study area. The unit includes areas of typical montane vegetation as found on landscape features such as Whaleback Ridge and the Bob Creek valley, and also includes plant and animal communities transitional between montane and subalpine communities on those portions of the study area transitional between the Montane and the Sub-Alpine natural subregions, such as in the vicinity of the Camp Creek valley, Chimney Rock and northeastern portions of the study area.

Significance: **National**

- the most extensive, least disturbed and relatively unfragmented area of East Slope Rocky Mountain Montane in Canada, with numerous provincially significant features
- considered as one of the best representatives of montane landscapes, flora and fauna in Canada, with very high habitat diversity
- considered one of the most significant elk winter ranges in the province
- significant elk summer range and calving areas
- provincially significant moose winter range, supporting one of the highest reported densities of moose in North America (lower Bob and Camp creeks)
- supports significant mule deer populations all year, including winter
- northern and altitudinal limit of range for sagebrush vole in Alberta
- mesic montane grasslands are inhabited by upland sandpipers
- supports numerous bird and mammal species which occur at the periphery of their range or as disjunct populations (such as loggerhead shrike, short-eared owl, Richardson's ground squirrel)
- provides habitat for numerous rare and uncommon plant species including, but not limited to, conimitella (*Conimitella williamsii*), silvery everlasting (*Antennaria luzuloides*), meadow aster (*Aster campestris*), yellow paintbrush (*Castilleja cusickii*), blue camas (*Camassia quamash* v. *quamash*), Raynold's sedge (*Carex raynoldsii*) and western sweet cicely (*Osmorhiza occidentalis*)
- old-growth Douglas-fir (*Pseudotsuga menziesii*) stands over 400 years old

- individual limber pine (*Pinus flexilis*) up to 575 years old. Full extent of old-growth limber pine in the study area is unknown to date
- contains numerous springs, with corresponding habitat values
- contains extensive low willow / dwarf birch communities. Such communities are relatively rare in the Montane Subregion
- numerous large glacial erratics can be found, particularly in southern portions of the unit
- fossil beds occur in the unit
- Whaleback Ridge and adjacent ridges, along with the Livingstone Sub-Alpine unit to the west, provide a relatively rare wilderness viewscape of high aesthetic value
- Whaleback Ridge is classed as a Special Level 2 theme, with Level 2 themes defined as having "distinctive vegetation assemblages and habitats and highly visible and extensive surficial geology components"

Sensitivity: High to Moderate

- sensitivity to disturbance is dependent on the inherent characteristics of each of the ELC units comprising the montane mosaic, as discussed in Section 4.5 of this report.
- grassland units in particular are susceptible to damage from off-highway vehicle traffic, particularly when wet.

Comments:

- Upper Bob Creek Ecological Reserve is located within the unit
- determination of the actual extent of old-growth limber pine in the study area warrants further investigations
- hydrological characteristics are such that artesian wells are relatively numerous

References:

- 1996 field investigations
- D. McIntyre, personal communication
- Alberta Environmental Protection (1995)
- Wallis (1994, 1980)
- Bradley et al. (1977)
- Downing and Karpuk (1994)
- Achuff (1994)

- Cottonwood Consultants Ltd. (1987)
- AWA (1986)
- Salt and Wershler (1975)
- English (1984)
- Radford (1975)
- Key Wildlife Area Map (82G), Alberta Environmental Protection

Area Name: **Livingstone Sub-Alpine**

Description:

- the unit encompasses those portions of the study area which lie within the Sub-Alpine Natural Subregion, and generally includes the western portion of the study area west of Camp Creek, and extending north. Landscape features included in the unit includes portions of the Livingstone Range as well as Chaffen Ridge and portions of Horseshoe Ridge. The unit is largely forested, with lodgepole pine and Engelmann spruce most prevalent.

Significance: **Provincial**

- the unit is of vital ecological importance to the adjacent, nationally significant Whaleback Montane, providing an extensive habitat linkage between the Whaleback Montane and the Front Ranges of the Rocky Mountains. As such, the unit plays a highly significant role as to why the Whaleback Montane itself is of national significance.
- rock outcrops and bluffs house numerous prairie falcon and golden eagle eyries
- caves and rock outcrops and overhangs also provide denning sites for large carnivores such as wolverine and cougar. The area supports one of the highest density populations of cougar in Alberta, estimated at 4.0 cougars/100 km^2.
- supports numerous species which are very rare or uncommon outside the Rocky Mountains (such as American dipper, golden-mantled ground squirrel, pika and Clark's nutcracker)
- although the extent of grizzly bear use of habitats in the Whaleback is unclear, grizzly bears have been seen in the area and it is likely that a few bears range through the area as part of their home range. Sub-alpine meadows and whitebark pine forests may be significant for these grizzlies, particularly because the Whaleback is linked to intact wilderness areas to the west.
- Chaffen Ridge, Horseshoe Ridge, and most of the Livingstone Range are significant bighorn sheep winter range
- rare plants include Pacific bluegrass (*Poa gracillima*), Wheeler's bluegrass (*Poa nervosa*), woolly hawkweed (*Hieracium cynoglossoides*) and silver-leaved scorpionweed (*Phacelia hastata*)

Sensitivity: Moderate to High

- sensitivity to disturbance is dependent on the inherent characteristics of each of the ELC units occurring in the unit, as discussed in Section 4.5 of this report.

Comments:

- ongoing timber harvesting along the slopes of the Livingstone Range is creating disturbance patterns within the unit, which may have implications concerning the ecological values of both this unit and the adjacent Whaleback Montane.

References:

- 1996 field investigations
- Jalkotzy et al. (1992)
- Wallis (1994)
- Key Wildlife Area Map (82G), Alberta Environmental Protection
- Alberta Environmental Protection (1995)
- Bradley et al. (1977)

Area Name: **Oldman River**

Description:

- the unit encompasses the Oldman River channel and its immediate terraces and associated cutbanks into glaciofluvial materials and bedrock. The opening in the Livingstone Range through which the river passes is known as "The Gap".

Significance: **Provincial**

- the reach of the Oldman River east of "The Gap" is a Class 1 trout stream, containing significant populations of sportfish including bull trout, cutthroat trout, rainbow trout and mountain whitefish
- supports a high density of breeding harlequin ducks at the Gap and upstream and downstream from the Gap
- incised cliffs and rock outcrops along banks provide nesting habitat for prairie falcon and, potentially, for peregrine falcon
- a buried native campsite, classed as a "Significant Historic Resource" is located at the Gap. Potential exists for similar sites to occur there.

Sensitivity: High

References:

- Alberta Environmental Protection (1995)
- Wallis (1994)
- Bradley et al. (1977)
- Nelson and Paetz (1992)
- Alberta Community Development (1993)
- Radford (1975)

4.4 Slope Classes

Slopes within the study area are highly variable and consist of both simple and of complex slopes. Simple slopes are slopes which are relatively uniform, such as those found on large, relatively undissected bedrock-controlled ridges in the study area, and on glaciofluvial terraces, alluvial fans and morainal areas with level to undulating topography. In contrast, complex slopes encompass a relatively wide variation of slope gradients within them, such as within areas dissected by streams, areas of slumping, and those bedrock-controlled areas transitional between the major ridges and bottomlands, with short slopes and rolling to ridged topography.

The Whaleback study area predominantly consists of extensive areas with strong relief and rugged topography. Slope classes presented on Map 3 serve to give a relative indication of the topographic complexity of the study area. Much of the study area is bedrock controlled, exhibiting ridged, rolling to inclined topography. The predominant slope class here is Class 6 (26 to 45 percent slope) with relatively minor occurrences of Class 7 (> 45 percent slope). Conversely, glaciofluvial terraces found extensively along the Oldman and Livingstone rivers, and occasionally along Chaffen Creek at the northern limit of the study area, display level to nearly level topography interspersed with scarp faces. Subdued topography can also be found within the Camp Creek, Bob Creek and Chaffen Creek drainages, as well as along the eastern perimeter of the study area. Riparian areas of major and minor creeks in the study area consist largely of complex slopes due to the many small fans, terraces and meander scars found within these areas.

Slope gradient and complexity have implications with regard to vegetation community establishment in terms of their effects on moisture regimes and on the intensity of aspect effects, both factors which affect, in part, the type of vegetation community found at a given site. Implications also exist with regard to the potential for erosion to occur within a given unit, which is one factor influencing the inherent sensitivity of an area to disturbance.

4.5 Sensitive Features

Environmental sensitivity ratings are often used as an evaluation of the performance of a site in response to various land uses or disturbance types (Bentz and Saxena 1993, O'Leary et al. 1993). On lands which have a low sensitivity to disturbance, many disturbances can be easily remedied by standard operating procedures. Conversely, other lands may be more sensitive to disturbance because they possess at least one of the following characteristics (Bentz and Saxena 1993):

- a very high susceptibility to erosion
- severe limitations to revegetation, or
- distinctive, rare or unusual landforms, wildlife populations or plant communities that are regionally, provincially, nationally or internationally important.

The Whaleback study area possesses all of the above characteristics, to varying degrees. The Whaleback study area itself is located in an area which, on a broad scale, is considered as having moderate wind erosion risk (Coote and Pettapiece 1989) and moderate water erosion risk (Tajek *et al.* 1985).

Coupled with biotic factors, the Whaleback study area can be considered as a relatively fragile area in general. However, some areas within the study area can be considered more fragile than others, and this difference is presented in Map 4 as a rating of the sensitivity of sites to physical disturbance, defined here as the degree of anticipated negative effects arising if the ground cover is disturbed by land use activities.

Very highly sensitive sites are defined here as those sites where any direct, indirect, spatial or temporal disturbance would result in a complete loss of environmental significance or value. Mitigation to maintain the vital ecological functions of the site would not be considered feasible without further scientific study.

Highly sensitive sites are those where disturbance would result in a severe loss of environmental significance or value, or would require the use of major mitigative techniques and very restrictive operating conditions to minimize this loss.

Sites with a moderate sensitivity rating could suffer a significant reduction in environmental significance as a result of disturbance, or would likely require significant mitigation and restrictive operating conditions to maintain the values of the site.

Sites with a low sensitivity are anticipated to experience minor negative effects resulting from physical disturbance within normal operating conditions. Some mitigation and normal operating restrictions may be necessary to ensure the long-term viability of the site.

Sites with insignificant sensitivity are those where the disturbance would have no measurable effect on the site.

Sensitivity ratings for the study area were generally based on ELC units, thus incorporating the edaphic and biotic attributes inherent within each ELC unit in the derivation of sensitivity ratings. In addition, the ecological significance of units with regard to wildlife (flora and fauna) habitat values, for example, was also considered in order to derive the sensitivity rating.

An important caveat to be kept in mind is that this exercise does not consider sensitivity to *specific* disturbances resulting from *specific* activities.

Three of the sensitivity classes defined above were mapped within the Whaleback study area: **Low, Moderate,** and **High**. The relationships between ELC units and sensitivity classes, along with the decision rules used to identify these relationships, are summarized in Table 5 below.

Table 5: Sensitivity classes related to ELC units for the Whaleback study area

SENSITIVITY CLASS	DECISION RULES	CORRESPONDING ELC UNITS
HIGH	- Montane and Sub-Alpine grasslands - southern aspects common, relatively dry - slopes generally greater than 30% - shallow soils - wildlife habitat values very high - easy access for motorized vehicles	VR1.5, VR1.6, VR1.10, VR1.12, XR1.2, GF3.1
	- riparian areas: - water quality and fisheries values (e.g. danger of sedimentation) in tributaries leading to Oldman and Livingstone rivers, or direct damage to Oldman and Livingstone rivers - wildlife habitat values very high	F1.1, F4.1, F4.2, F4.3
	- wetlands: - organic veneers and blankets - poor to very poor drainage - high wildlife habitat values	W1.1, W1.2, W2.1, W2.2
	- colluvium: - mass wasting, slumps, scarp faces - unstable slopes - slopes generally greater than 30%	C1.1, C1.2, C1.3, C2.1, C2.2, C3.1

SENSITIVITY CLASS	DECISION RULES	CORRESPONDING ELC UNITS
	- forested - slopes greater than 30% - generally southern aspects - southern aspects and open forest canopy suggests relatively drier sites of less productivity than other forested units - shallow soils - easy access for motorized vehicles	VR1.4
	- very high wildlife values - shallow soils	VR2.1 and VR2.2 (both in Sub-Alpine)
	- dissected, complex slopes - slopes greater than 30%	VR3.1
	- slopes greater than 30% - southern aspects generally, therefore relatively drier - often are brush-encroached former grassland areas - shallow soils - high wildlife habitat values	VR1.7
	- slopes generally greater than 30% - shallow soils - high wildlife habitat values	XR1.1, XR1.3
	- slopes generally greater than 30% - dissected, complex slopes - shallow soils - high wildlife habitat values	XR2.1, XR2.2

SENSITIVITY CLASS	DECISION RULES	CORRESPONDING ELC UNITS
	- mosaic of shrub, deciduous and coniferous forest, and open, south-facing grassland patches create high habitat diversity, therefore high wildlife values - slopes generally greater than 30% - shallow soils	VR1.9
MODERATE	- forested - slopes greater than 30% - generally southern aspects - southern aspects and semi-open forest canopy implies relatively drier sites, may be less productive than other forested units - shallow soils	VR1.3
	- upper terraces and fans: - flood hazard - high water table - wildlife habitat values	F2.1, F2.2, F3.1, F3.2
	- ephemeral drainage areas which have been cultivated - possible flood hazard	F4.4
	- forested - slopes greater than 30% - shallow soils	VR1.1, VR1.2, VR1.8, VR1.11, VR1.14
	- complex of forested units with inclusions of small, south-facing grassland units of high sensitivity - wildlife habitat values - slopes greater than 30% - shallow soils	VR1.13
	- slopes greater than 30%	GF2.1, GF2.2, GF3.2

SENSITIVITY CLASS	DECISION RULES	CORRESPONDING ELC UNITS
	- glaciofluvial terraces, commonly with shallow organic deposits or moist to wet mineral soils - slopes less than 15%	GF1.3
	- moist grassland seepage areas with forbs and shrubs - wildlife habitat values	M1.6
	- moist, forested seepage areas - wildlife habitat values	M1.8
	- slopes less than 30% - relatively deep soils - wildlife habitat values	VR2.1 and VR2.2 (both in Montane)
	- slopes up to 45% - often relatively drier south aspects in units where grasslands occur in conjunction with forested units - units often occur adjacent each other, forming extensive areas which, when considered together, form a mosaic of habitat types - wildlife habitat values are the driving criteria	all MR1 and MR2 units
	- bedrock - strong to very steep slopes	R.1.1, R1.2
	- slopes to 70%+ - grasslands	GF4.1
LOW	- slopes less than 15% - deep soils	GL1.1, all M1 units except M1.6 and M1.8
	- glaciofluvial terraces - slopes less than 15%	GF1.1, GF1.2

A significant portion of the Whaleback study area has been classed as having high sensitivity to disturbance. Areas with a high sensitivity to disturbance include relatively dry areas of strong relief, usually the result of bedrock control, as found in Montane and Sub-Alpine grasslands; areas

of erosion by mass wasting, water or by extensive slumping; riparian areas of permanent and ephemeral streams; and wetlands. The units tend to be easily disturbed by motor vehicles. As well, wildlife habitat values associated with these units are generally high.

A large portion of the study area is classed as having moderate sensitivity to disturbance. Areas with moderate sensitivity to disturbance include mesic or moister forested areas of strong relief commonly found throughout the Sub-Alpine portions of the study area, transitional areas between the Sub-Alpine and the Montane, and on northern aspects in Montane portions. Other extensive areas of moderate sensitivity include grassland and forested areas occurring on bedrock-controlled morainal areas common along the lower slopes of major Montane ridges and adjacent valley edges. Topography in these types is relatively subdued. High wildlife habitat values associated with these areas are the driving criteria for the moderate sensitivity rating here. Other areas of moderate sensitivity include bedrock units and pitted glaciofluvial terraces of strong relief.

Areas classed as having a low sensitivity to disturbance include bottomland morainal, glaciofluvial and glaciolacustrine deposits with deep soils and very subdued topography.

It should also be noted that sensitivity ratings as presented on Map 4 should only serve as a general indication of sensitivity within each polygon. Site-specific investigations are recommended prior to land-use activity at any particular site.

4.6 Disturbance Features

The impact of man's activities on the Whaleback study area is readily observed from both the ground and from aerial photographs. Areal disturbances have been caused by timber harvesting, by the past cultivation of land and the creation of tame or "improved" pasture. Linear disturbances have resulted from petroleum exploration, fencelines and vehicle trails. Disturbance features are depicted on Map 5.

It appears that land totalling nearly 2.75 quarter sections has previously been broken within the Whaleback study area for agricultural purposes. This equates to approximately 0.004 percent of the entire study area. Cultivation for the most part has been limited to lands with simple slopes of low relief, as found on the terraces of the Oldman River and within the valley bottom of Chaffen Creek in particular. Isolated areas of cultivation can also be found in the Bob Creek valley and on localized relatively level areas scattered through southern portions of the study area. Cultivated units shown on Map 5 represent improved pasture areas and areas which have been cultivated in the past but which are now reverting to native prairie.

Associated with this agricultural development are 12 permanent farm residences, 1 individual building site, 5 corrals, 5 dugouts, 3 reservoirs and approximately 78.5 km of fencelines. As well, eight small permanent snowfences, each approximately 30 to 40 meters long, are located west of

a gravel road adjacent to Bob Creek in the southern portion of the area. Farm residences and cultivated areas are generally limited to the southern and northern perimeters of the study area.

Water developments are somewhat frequent in the southern and eastern portions of the study area. Occasional dugouts have been constructed in some ephemeral drainages on upland areas, however, the majority of dugouts are found in close association with ephemeral drainages and minor riparian areas in close proximity to Whaleback Ridge. Reservoirs are few, generally created as a result of small earth dams within ephemeral and small, permanent drainage channels in the study area. Though dugouts and reservoirs are man-made, they can have relatively important wildlife values associated with them, particularly as water sources and in the provision of habitat for wildlife species which require habitat conditions which can exist around watering areas, such as sparsely vegetated, trampled areas for example. Though not mapped as disturbance features, at least five artesian wells were observed within valley bottoms associated with Whaleback Ridge and other ridges bordering the Bob Creek valley.

Approximately 288.5 km of roads and trails occur within or bordering the study area. Of this, there are approximately 54.2 km of gravelled, all-weather roads, including Secondary Road 940 (Forestry Trunk Road) and Secondary Highway 517. In addition, an extensive trail network has been created throughout the area in response to agricultural developments, past oil and gas exploration and recreational off-highway vehicle use, with approximately 234.3 km of vehicle trails mapped in the study area.

A number of seismic lines occur throughout the study area. These seismic lines total approximately 161.6 km in length.

One major pit has been identified within the study area, from which sand and gravels are being extracted.

Cutblocks as a result of timber harvesting are limited to western portions of the study area within the Livingstone range. Three cutblocks totalling approximately 114.8 hectares were mapped from 1991 aerial photography. Cutblock disturbances are expected to be greater than those mapped, as further timber harvesting in this area was ongoing during 1996.

5.0 DATA GAPS

Recently emerging concepts and principles of landscape ecology, ecosystem-based management, and conservation biology will be useful in guiding a broad, coarse-filtered land use philosophy for the Whaleback, thus allowing the perpetuation of the pristine, intact, and contiguous nature of one of Alberta's most prized wilderness areas. The success of such an endeavour, however, will require its active integration with fine-filtered approaches that seek to identify and quantify specific conservation values towards which efforts can be directed and results can be measured.

The level to which specific resource conservation values have been identified in the Whaleback study area are extremely varied at present. While it is true that much recent attention has been given to the significance of the Whaleback area by both government agencies (AEP 1996) and environmental NGOs (Kolar and Brawn 1986), much of this focus has been from a regional landscape perspective - a perspective which is well-warranted and long overdue. Investigations into specific elements within the Whaleback study area, however, have concentrated on rare plant occurrences and on the distribution of vegetation communities (e.g. Wallis 1994 and 1980, Alberta Environmental Protection 1995, Cottonwood Consultants 1987, Bradley *et al.* 1977, O'Leary *et al.* 1989, Alberta Energy and Natural Resources 1979).

However, the continuation of such investigation is still necessary for the study area. For example, individual limber pine trees between 250 to 575 years old have recently been found to occur in the study area (McIntyre 1997). The full extent of old-growth limber pine in the study area is not known to date and deserves further study. As well, the documentation of rare plant occurrences within and in the vicinity of the study area tends to be restricted to specific management areas such as the Upper Bob Creek Ecological Reserve, various provincial recreation areas, and the Mount Livingstone Natural Area immediately north of the study area; or along areas of relatively easy access (Alberta Natural Heritage Information Centre files). The Sub-Alpine portion of the study area is particularly devoid of rare plant documentation, though rare plant occurrences have been documented in areas of the Sub-Alpine Natural Subregion along the periphery or immediately outside of the study area. Further investigations of rare plant occurrences within the majority of the study area away from these sites would help to provide a more comprehensive picture of the distribution of rare flora or significant plant communities throughout the study area as a whole.

Relatively little attention has been given to the faunal element of the Whaleback area, with the exception of the fisheries of the Oldman River (Radford 1975, English 1984) and ungulates, particularly elk (Strong and Vriends 1980, O'Leary et al. 1989). While significant fauna have been described for the area by various authors, these characterizations have been based largely on informal, reconnaissance-level field work (such as Wallis 1980, Bradley *et al.* 1977) or on incidental observations (Salt and Wershler 1975, Wallis 1994, for example). In particular, the local

ecology of range peripheral species and naturally rare or scarce species is largely speculative. There is very little hard data from which to evaluate actual patterns of use of the Whaleback area by grizzly bear, wolverine, gray wolf, cougar, short-eared owl, long-billed curlew, and even golden eagles and prairie falcons.

For many large, vagile mammals of southwestern Alberta, the Whaleback study area is likely to be encompassed within the home range of more than one individual of numerous given species. Incidental observations of grizzly bears, black bears, gray wolves, coyotes, cougars, lynx, bobcat, and wolverine have all been reported for the Whaleback region, but detailed information regarding spatial and temporal patterns of habitat use are extremely deficient. For many of these species, it is not known whether the Whaleback area itself functions in (i) providing critical life requisites, such as denning or primary foraging habitats; (ii) providing funnel, movement, or dispersal corridors; (iii) providing links between two more optimal habitats; or (iv) providing sub-optimal habitat that is being used in lieu of other more optimal, but inaccessible, habitats.

Detailed inventories and ecological research are the only reliable methods of acquiring this data but such efforts have been rare to date. Therefore, there is an immediate need for ecological research designed to meet explicitly stated objectives because numerous questions remain unanswered:

- *"What is the full extent of old-growth limber pine within the Whaleback study area, and how does their distribution and age compare with other areas in southwestern Alberta?";*
- *"What is the distribution of rare plant species occurrences within areas not yet investigated for such in the Whaleback study area, and what are the relationships between their habitats and ecological land classification (ELC) units for the study area? Can rare flora occurrence be reasonably predicted based on these relationships? Can such predictors be used in order to assist in the management of the area?";*
- *"What is the relationship, if any, between grizzly bears, red squirrels, and whitebark pine communities in the sub-alpine environment?";*
- Cougar population and density estimates throughout Alberta are extrapolations, based on one study completed in the Sheep River area. Therefore, *"What are the actual use patterns of wild felids in this area?"; "What are cougar's predation patterns and how are they affected by varying use of winter ranges by deer and elk in the region?";*
- *"Why are river otters so scarce in the Oldman River when suitable habitat seems to exist for them? What is the potential for re-introduction of river otter in this area? Should re-introduction of the species be considered?";*
- *"What are the factors that influence the sympatry and spatial relationships of large carnivores in the area?";*
- *"What is the potential for peregrine falcons re-colonizing and establishing nest sites along the Oldman River?";*
- *"What are the factors affecting nest site selection by short-eared owls and by long-billed curlews, both of which nest regularly immediately east of the Whaleback area? What is the actual nesting frequency of these species within the study area?"*

The paucity of information concerning these, and other, species in the Whaleback area has resulted in a reliance on broader, more easily defined "landscape" issues when discussing the potential conservation value of the area. Even when viewed in the "big picture", however, the Whaleback region is still a "component" of a large, undisturbed wilderness area that houses numerous species both within and through its bounds. Therefore, the Whaleback's role in the overall landscape needs to be quantified for certain species in order for active management and conservation to proceed in a manner that preserves the integrity of the region's native biota.

6.0 GENERAL OBSERVATIONS OF THE STUDY AREA

The Whaleback study area encompasses a landscape that has been revered by conservation organizations, government agencies, recreational users, and industrial groups alike. Although the general significance of the area has been widely recognized, Section 5.0 of this report certainly shows that the area is largely depauperate of site-specific information from which to justify management of resource values. Despite the lack of quantitative data on numerous natural elements within the Whaleback, many features have been identified, at least on a broad scale, which give the region as a whole a national significance.

One of the most notable characteristics of the Whaleback study area is the relatively undisturbed nature of the study area when compared with surrounding areas and with other Montane areas of Alberta and adjacent portions of British Columbia. Such an unfragmented situation is rare for Montane areas in Alberta and adjacent portions of British Columbia. This, coupled with the function of Sub-Alpine portions of the study area as providing a habitat linkage for the Whaleback Montane to the Front Ranges of the Rocky Mountains, provides an important contribution to the consideration of the Whaleback Montane within the study area as being a wilderness area of national significance.

Another notable characteristic of the Whaleback study area is the high degree of climatic and topographic diversity within the study area, leading to a corresponding high degree of floral and faunal habitat diversity. The study area straddles the Montane and Sub-Alpine natural subregions, and much of the study area displays properties transitional between the two subregional climates, as reflected in the vegetation communities which occur in the transition zone. As such, macroclimatic differences in the study area contribute to the high habitat diversity of the area, due to the occurrence of vegetation communities typical of Montane communities, vegetation communities typical of Sub-Alpine communities, and vegetation communities which display properties of both. As well, topography of the study area is very complex, leading to large variations in microclimate and moisture regimes which result in diverse plant community patterns that are strongly aspect-controlled and which also contribute to high habitat diversity in the study area.

The Whaleback is noted for its diverse assemblage of fauna, including a variety of birds, mammals, herptiles, and fish. Of particular significance is the provision of winter range for numerous ungulates such as elk, moose, mule deer, and bighorn sheep. The montane grasslands within the study area comprise one of the two most significant elk winter ranges in the province with both resident and migrant elk using these wind-swept and snow-free habitats. In addition, low willow - shrub communities along the lower reaches of Bob Creek, for example, house one of the highest winter densities of moose in Alberta, and possibly in North America. Among other species guilds, the Whaleback should also be considered as housing a significant complex of large carnivores. Eight species of large carnivores - including grizzly bears, black bears, gray wolves, coyotes, wolverines, cougar, lynx, and bobcat - inhabit the area, making it one

of the richest sites in the critical Rocky Mountain Natural Region for these carnivores, most of which require vast areas of undisturbed wilderness. As a matter of fact, the region has been cited by previous authors as housing one of the highest densities of cougar in Alberta.

Golden eagles and prairie falcons are a component of a very diverse avian community in the Whaleback study area. Suitable reproductive habitat also exists for numerous other species - such as peregrine falcon, short-eared owl, and long-billed curlew - which have been seen in the study area but have not been as-of-yet confirmed as breeding here. The Oldman River itself, which flows through the extreme southern portion of the Whaleback study area, is classified as a Class 1 trout fishery containing significant populations of sportfish including bull trout, cutthroat trout, rainbow trout, and mountain whitefish.

The diversity of climate, landforms and sites found in the Whaleback study area, coupled with the relatively unfragmented nature of the study area, has provided habitat not only for representative Montane, Sub-Alpine and transitional plant and animal communities, but has also served to provide habitat for extensive stands of Douglas-fir, some of which is old-growth of more than 400 years of age, individual limber pine trees between 250 and 575 years old, numerous rare plant species and significant faunal species, and provides a rare example of Montane wilderness and viewscapes. These factors on their own could be considered as constraints to the capability of the landbase to support development activities, even before physical site limitations are considered. As well, increased recreational activity in the area, particularly with regard to motorized vehicle traffic, will have concomitant impacts on the landbase, particularly on grassland and open forested areas, as well as on wildlife. For example, Boyle and Samson (1983) listed 536 literature references that identified the effects of nonconsumptive outdoor recreation on terrestrial vertebrates in North America. More than 81 percent of these articles reported negative effects on wildlife while less than 7 percent reported positive effects. These negative impacts included altered behavior, movements and distributions, increased nesting failure, and expenditure of critical energy reserves. Access management will continue to be an important consideration for the study area.

Though the study area is relatively unfragmented, disturbances to the landscape can be found. The major disturbance to natural vegetation cover within the study area are cutblocks created as a result of past and ongoing timber harvesting on the slopes of the Livingstone Range. As well, some cultivation for tame forages has occurred, largely concentrated in southern portions of the study area on the terraces of the Oldman River, on isolated portions of the Bob Creek valley, and in the vicinity of Chaffen Creek at the northern end of the area. Seismic cutlines are relatively frequent throughout the study area. Numerous vehicle trails occur, particularly throughout the Montane and Montane - Sub-Alpine transitional areas on grasslands, open forests and along riparian areas.

7.0 LITERATURE CITED

Achuff, P.L. 1994. Natural regions, subregions and natural history themes of Alberta: a classification for protected areas management. Prepared for Parks Services, Alberta Environmental Protection.

Adams, A.W. 1992. Migration. Pages 301-322 in: Thomas, J.W. and D.E. Toweill (eds). *Elk of North America: Ecology and Management*. The Wildlife Institute. Washington, DC.

Alberta Community Development. 1993. Significant sites and areas listing: updated to January 31, 1993. Historic Sites Service, Alberta Community Development. Edmonton.

Alberta Energy and Natural Resources. 1979. Ecological land classification and evaluation: Livingstone - Porcupine. ENR Report No. 94. Resource Inventory and Appraisal Section, Resource Evaluation Branch. Edmonton, AB.

Alberta Energy and Natural Resources. 1987. Livingstone-Porcupine Sub-Regional Integrated Resource Plan. Alberta Forestry, Lands and Wildlife, Resource Evaluation and Planning Division. Edmonton, AB.

AEP (Alberta Environmental Protection). 1996. The status of Alberta wildlife. Alberta Environmental Protection, Wildlife Management Division. Edmonton, AB. 44 pp.

AEP. 1995. Alberta's Montane Subregion, Special Places 2000 and the significance of the Whaleback Montane. Heritage Protection and Education Branch, Parks Management Support Division, Natural Resources Service. Edmonton, AB.

AEP. 1994a. Natural regions and subregions of Alberta. 1:1 000 000 scale map.

AEP. 1994b. Ecological land survey site description manual. Canadian Forest Service and Alberta Land and Forest Services. Edmonton, AB.

AEP. 1993. Alberta plants and fungi - master species list and species group checklists. Publ. No.: Ref. 75. Alberta Environmental Protection. Edmonton, AB.

AFWD (Alberta Fish and Wildlife Division). 1990. Alberta's threatened wildlife - bull trout. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 5 pp.

AFWD. 1991. The status of Alberta wildlife. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 49 pp.

Alberta Forest Service. 1990. Range Survey Manual. Third edition. Forest Land Use Branch, Alberta Forestry, Lands and Wildlife. Edmonton, AB.

Alberta Natural Heritage Information Centre (ANHIC). 1997. A.N.H.I.C. files. Parks Management Support Division, Natural Resources Service, Alberta Environmental Protection. Edmonton.

Allen, J.N. 1980. The ecology and behavior of the long-billed curlew in southeast Washington. Wildl. Monogr. No. 73. 67 pp.

Alley, N.F. 1972. Quaternary history of part of the Rocky Mountain Foothills, Plains and western Porcupine Hills, southwestern Alberta. M.A. Thesis. Dept. of Geography, University of Calgary. Calgary, AB.

Archibald, J.H., G.D. Klappstein and I.G.W. Corns. 1996. Field guide to ecosites of southwestern Alberta. Natural Resources Canada, Canadian Forest Service, Northwest Region, Northern Forestry Centre. Edmonton, AB. Special Report 8.

Arno, S.F. and R.J. Hoff. 1989. Silvics of whitebark pine (*Pinus albicaulis*). Gen. Tech. Rep. INT-253. United States Department of Agriculture, Intermountain Research Station. Ogden, UT.

Avery, E.L. 1983. A bibliography of beaver, trout, wildlife and forest relationships. Tech. Bull. No. 137. Wisconsin Department of Renewable Resources. Madison, WI.

Banci, V. 1987. Ecology and behavior of wolverine in the Yukon Territory. M.Sc. Thesis. Simon Fraser University. Burnaby, BC.

Banci, V. 1991. Status report on the grizzly bear, *Ursus arctos horribilis*, in Canada. COSEWIC Status Report. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 171 pp.

Banci, V. 1994. Wolverine. Chapter 5 in: Ruggiero et al. (eds). The Scientific Basis for Conserving Forest Carnivores in the Western United States. Gen. Tech. Rep. RM-254. United States Department of Agriculture. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Banfield, A.W.F. 1981. *The Mammals of Canada*. University of Toronto Press. Toronto, ON.

Barinaga, M. 1990. Where have all the froggies gone? Science 247: 1033-1034.

Beauvais, G., J.H. Enderson, and A.J. Magro. 1992. Home range, habitat use, and behavior of prairie falcons wintering in eastern Colorado. J. Raptor Res. 26: 13-18.

Bentz, J.A., A. Saxena, and T.T. Normand. 1995. Environmentally significant areas inventory of the Foothills Natural Region, Alberta. Prepared by Geowest Environmental Consultants Ltd. for Alberta Environmental Protection, Resource Data Division. Edmonton, AB. 142 pp. + App.

Bentz, J.A. and A. Saxena. 1993. Significant ecological inventory of the Lesser Slave Lake Integrated Resource Planning Area. Prepared for Resource Information Division, Alberta Environmental Protection, Edmonton, AB by Geowest Environmental Consultants Ltd., Edmonton, AB.

Berry, D.K. 1994. Alberta's bull trout management and recovery plan. Alberta Environmental Protection, Fish and Wildlife Services. Edmonton, AB. 22 pp.

Birks, J.D.S. and I.J. Linn. 1982. Studies of home range of feral mink (*Mustela vison*). Symp. Zool. Soc. of London 49: 231-257.

Bishop, C.A. and K.E. Petit (eds). 1992. Declines in Canadian amphibian populations: Designing a national monitoring strategy. Occ. Paper No. 76. Canadian Wildlife Service. Ottawa, ON. 120 pp.

Blaustein, A.A. and D.B. Wake. 1990. Declining amphibian populations: A global phenomenon. Trends Ecol. Evol. 5: 203-204.

Boag, T.D. 1987. Food habits of bull char, *Salvelinus confluentus*, and rainbow trout, *Salmo gairdneri*, coexisting in a foothills stream in northern Alberta. Can. Field-Nat. 101(1): 56-62.

Borchert, J.R. 1950. The climate of central North American grassland. Ann. Assoc. Amer. Geog. 40:1-39. *cited in:* Duffy, R.G.Q. 1971. An ecological study of vegetation change in the northern Porcupine Hills, Alberta. M.A. Thesis. Dept. of Geography, University of Calgary, Calgary, Alberta.

Boyd, D.K., P.C. Paquet, S. Donelon, R.R. Ream, D.H. Pletscher, and C.C. White. 1995. Dispersal characteristics of a recolonizing wolf population in the Rocky Mountains. In: Carbyn, L.N. (ed). *2nd North Amer. Symp. on Wolves*. University of Alberta Press. Edmonton, AB.

Bradley, C., L. Bradley and J. Gilpin. 1977. A study of parks potential in the Eastern Slopes. Alberta Parks Planning Branch, Parks Division, Alberta Recreation, Parks and Wildlife.

Bradshaw, D.A., A. Saxena, and I.D. MacDonald. 1996. Biophysical overview, significant, sensitive, and disturbance features of the Eagle Butte Sensitive Area, Alberta. Prepared by Geowest Environmental Consultants Ltd. for Alberta Environmental Protection. Edmonton, AB. 148 pp.

Breault, A.M. and J.P.L. Savard. 1991. Status report on the distribution and ecology of harlequin ducks in British Columbia. Tech. Rep. Ser. No. 110. Canadian Wildlife Service, Pacific and Yukon Region. Delta, BC.

Breitung, A.J. 1954. A botanical survey of the Cypress Hills. Can. Field. Nat. 68:55-92.

Brierley, D., D. Bradshaw and D. Downing. 1989. Milk River Natural Area biophysical inventory - southern uplands. Publ. No. T/194. Alberta Forestry, Lands and Wildlife, Land Information Services Division, Edmonton, AB.

Brooks, B.L. and S.A. Temple. 1990. Habitat availability and suitability for loggerhead shrikes in the upper midwest. Am. Midl. Nat. 123: 75-83.

Brown, G., E. Gasser, and P. MacIsaac. 1986. Biophysical features and land uses: Upper Bob Creek Candidate Ecological Reserve. Alberta Recreation and Parks. Edmonton, AB.

Bruhjell, D.R., P.M. Sherrington, J.A. Bentz, and A. Saxena. 1997. Biophysical and significant ecological features of the Kootenay Plains Ecological Reserve. Prepared by Geowest Environmental Consultants Ltd. for Alberta Environmental Protection, Resource Data Division. Edmonton, AB. 145 pp.

Buskirk, S.W. 1992. Conserving circumboreal forests for marten and fisher. Cons. Biol. 6: 318-320.

Buskirk, S.W. and R.A. Powell. 1994. Habitat ecology of fishers and American martens. Pages 283-296 in: Buskirk, S.W., A.S. Harestead, and M.G. Raphael (eds). *Martens, Sables, and Fishers: Biology and Conservation*. Cornell University Press. Ithaca, NY.

Cadman, M.D. 1994. Status report on the short-eared owl (*Asio flammeus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 53 pp.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The Birds of British Columbia. Vol. 2: Non-Passerines. Royal British Columbia Museum. Victoria, BC.

Carbyn, L.N. 1977. Preliminary analysis of wolf-ungulate interactions with specific reference to moose in Riding Mountain National Park, Manitoba. 13th N. Amer. Moose Conf. and Wkshp.: 283-289.

Chilibeck, B., G. Chislett, and G. Norris. 1992. Land development guidelines for the protection of aquatic habitats. British Columbia Ministry of Environment, Lands and Parks. Victoria, BC.

Clark, J. 1995. 1994-95 Southern foothill - mountain elk survey. Unpubl. report. Alberta Environmental Protection, Wildlife Management Division. Blairmore, AB. 62 pp.

Clark, R.J. 1975. A field study of the short-eared owl (*Asio flammeus* Pontoppidian) in North America. Wildl. Monogr. No. 47.

Coady, J.W. 1982. Moose. Pages 902-922 in: Chapman, J.A. and G.A. Feldhamer (eds). *Wild Mammals of North America*. Johns Hopkins University Press. Baltimore, MD.

Cobb, T.P. and J.L. Morissette. 1996. Status report on the sagebrush vole, *Lemmiscus curtatus*, in Canada. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 21 pp.

Coote, D.R. and W.W. Pettapiece. 1989. Wind erosion risk: Alberta. Land Resource Research Centre, Agriculture Canada, Research Branch. Publication 5255/B. Contribution No. 87-08.

COSEWIC. 1996. Canadian species at risk. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

Cottonwood Consultants Ltd. 1987. Environmentally significant areas in the Oldman River Region: Municipal District of Pincher Creek. Prepared for Resource Evaluation and Planning, Alberta Forestry, Lands and Wildlife, Edmonton, AB and Oldman River Regional Planning Commission, Lethbridge, AB.

Coupland, R.T. and T.C. Brayshaw. 1953. The fescue grassland in Saskatchewan. Ecology 34:386-405.

Court, G.S. 1994. Population dynamics of American peregrine falcons *(Falco peregrinus anatum)* breeding in northeastern Alberta, Canada (1971-1993): An evaluation of the need for continued management. Occas. Rep. Series No. 14. Alberta Environmental Protection, Fish and Wildlife Services. Edmonton, AB. 25 pp.

Cramp, S. and K.E.L. Simmons. 1980. *Handbook of the Birds of Europe, the Middle East, and North Africa*. Vol. 2. Oxford University Press. Oxford.

D.A. Westworth & Associates Ltd. 1992. An overview of potential forest harvesting impacts on fish and fish habitats in the northern boreal forests of Canada's prairie provinces. Prepared for Department of Fisheries and Oceans Canada. var. pp.

DeGraaf, R.M., V.E. Scott, R.H. Hamre, L. Ernst, and S.H. Anderson. 1991. Forest and Rangeland Birds of the United States: Natural History and Habitat Use. Agricultural Handbook. United States Department of Agriculture. Washington, DC.

De Smet, K.D. 1987. Status report on the golden eagle, *Aquila chrysaetos*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

De Smet, K.D. 1992. Status report on the long-billed curlew (*Numenius americanus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 28 pp.

De Smet, K.D. 1993. Status of ferruginous hawk and loggerhead shrike recovery efforts. Pages 329-332 in: Holroyd, G.L., H.L. Dickson, M. Regnier, and H.C. Smith (eds.) *Proc. of the Third Prairie Conserv. and Endang. Spec. Wkshp.* Nat. Hist. Occas. Paper No. 19. Provincial Museum of Alberta. Edmonton, AB.

Diamond, A. 1988. An evaluation of the vulnerability of Canadian migratory birds to changes in neotropical forest habitats. Blue Jay News 77: 14-15.

Downing, D.J. and E. Karpuk. 1994. Special features for Upper Bob Creek Ecological Reserve. Draft map. Alberta Environmental Protection, Edmonton.

Duebbert, H.F. and J.T. Lokemoen. 1977. Upland nesting of American bitterns, marsh hawks, and short-eared owls. United States Fish and Wildlife Service, Northern Prairie Wildlife Research Center. 40 pp.

Duffy, R.G.Q. 1971. An ecological study of vegetation change in the northern Porcupine Hills, Alberta. M.A. Thesis. Dept. of Geography, University of Calgary, Calgary, Alberta.

Eagles, P. 1984. The Planning and Management of Environmentally Sensitive Areas. Longman: London and New York.

Eckert, A.W. 1974. *The Owls of North America*. Doubleday, New York.

Edwards, B.F. 1974. A resource planning study of the wildlife of Cypress Hills Provincial Park, Alberta. M.Sc. Thesis. University of Calgary. Calgary, AB. 137 pp.

Enderson, J.H., G.R. Craig, W.A. Burnham, and D.D. Berger. 1982. Eggshell thinning and organochlorine residues in Rocky Mountain peregrines, *Falco peregrinus*, and their prey. Can. Field-Nat. 96: 255-264.

English, W.G. 1984. Bob Creek Stream Survey Inventory. Alberta Energy and Natural Resources, Fish and Wildlife Division. Lethbridge, AB.

Environment Canada. 1993. Canadian climate normals 1961 - 1990: v. 2: Prairie Provinces. Atmospheric Environment Service, Environment Canada, Ottawa.

Etter, H.M. 1972. Protection and reclamation of bighorn sheep range in the foothills of Alberta. Paper presented at the Northern Wild Sheep Council Meeting, Hinton, AB.

Evans, C.D., W.A. Troyet, and C.J. Lensink. 1966. Aerial census of moose by quadrat sampling units. J. Wildl. Manage. 30(4): 767-776.

Fairbarns, M. 1989. The East Porcupine Ecologically Significant Area: conservation values and management concerns. Draft document.

Fargey, P.J. 1988. Wapiti selection of grasses and legumes. Pages 24-26 in: Renecker, L.A. (ed). *Proc. of the 3rd Annual Game Growers Assoc. Conf.* Red Deer, AB.

Fargey, P.J. and A.W.L. Hawley. 1989. Seasonal patterns of forage selection by wapiti (*Cervus elaphus*) in relation to land reclamation. AECV89-R3. Alberta Environmental Center. Vegreville, AB. 112 pp.

Fitzner, J. N. 1978. The ecology and behavior of the long-billed curlew (*Numenius americanus*) in southeastern Washington. Ph. D. thesis, Washington State University. Seattle, WA.

Foreman, D. 1992. Developing a regional wilderness recovery plan. Pages 26-29 in: Wild Earth (special issue), Plotting a North American Wilderness Recovery Strategy. The Wildlands Project. Canton, NY.

Gardner, C.L. 1985. The ecology of wolverines in southcentral Alaska. M.Sc. Thesis. University of Alaska. Fairbanks, AK.

Gauthier, G. and J.N.M. Smith. 1987. Territorial behavior, nest site availability, and breeding density in bufflehead. J. Anim. Ecol. 56: 171-184.

Glasgow, W.M., D.L.J. Moyles, and A.W. Todd. 1995. Management plan for white-tailed deer in Alberta. Wildl. Manage. Planning Ser. No. 11. Alberta Environmental Protection, Natural Resources Service. Edmonton, AB. 142 pp.

Godfrey, W.E. 1986. *The Birds of Canada*. National Museum of Natural Sciences. Ottawa, ON. 595 pp.

Greenlee, G.M. 1981. Guidebook for use with soil survey reports of Alberta provincial parks and recreation areas. Earth Sciences report 81-1. Alberta Research Council. Edmonton, AB.

Gunson, J.R. 1989. Management plan for mule deer in Alberta. Wildl. Manage. Planning Ser. No. 1. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 141 pp.

Gunson, J.R. 1992. Management plan for elk in Alberta. Wildlife Management Planning Series No. 8. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB.

Gunson, J.R. and B.H. Treichel. 1987. Data-base of mortalities of grizzly bears in Alberta during 1972-1987. Unpubl. Rep. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 55 pp.

Hagmeier, E.M. and C.D. Stults. 1964. A numerical analysis of the distributional patterns of North American mammals. Systematic Zoology 13: 125-155.

Hamer, D. and S. Herrero. 1983. The grizzly bear in Waterton Lakes National Park, progress report for 1982. University of Calgary. Calgary, AB.

Hands, H.M., R.D. Drobney, and M.R. Ryan. 1989. Status of the loggerhead shrike in the northcentral United States. Missouri Coop. Wildl. Research Unit. Columbia, MO. 15 pp.

Harris, L.D. 1988. The nature of cumulative impacts on biotic diversity of wetland vertebrates. Environ. Manage. 12(5): 675-693.

Hill, E.P. 1982. Beaver. Pages 256-281 in: Chapman, J.A. and G.A. Feldhamer (eds.) *Wild Mammals of North America*. Johns Hopkins University Press. Baltimore, MD.

Horejsi, B.L. 1986. Industrial and agricultural incursion into grizzly bear habitat: The Alberta story. Pages 116-123 in: Contreras, G.P. and K.E. Evans (eds). *Proc. Grizzly Bear Habitat Symp*. Gen. Tech. Rep. GTR-INT-207. United States Department of Agriculture, Intermountain Forest Research Station. Ogden, UT.

Hornocker, M.G. 1970. An analysis of mountain lion predation on mule deer and elk in the Idaho Primitive Area. Wildl. Monogr. 21.

Hornocker, M.G. and H.S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Can. J. Zool. 59: 1286-1301.

Hunt, L.E. 1993. Diet and habitat use of nesting prairie falcons (Falco mexicanus) in an agricultural landscape in southern Alberta. M.Sc. Thesis. University of Alberta. Edmonton, AB.

Hunter, M.L. 1990. *Wildlife, Forests, and Forestry - Principles of Managing Forests for Biological Diversity*. Prentice-Hall. New Jersey. 370 pp.

Hutchins, H.E. and R.M. Lanner. 1982. The central role of Clark's nutcracker in the dispersal and establishment of whitebark pine. Oecologia 55: 192-201.

Jackson, P.C. 1981. Geological highway map of Alberta. Geological Highway Map Series, Canadian Society of Petroleum Geologists.

Jalkotzy, M., I. Ross, and J.R. Gunson. 1992. Management plan for cougars in Alberta. Wildl. Manage. Planning Ser. No. 5. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 91 pp.

Jenni, D.A., R.L. Redmond, and T.K. Bicak. 1982. Behavioral ecology and habitat relationships of long-billed curlews in western Idaho. United States Bureau of Land Management. Boise, Idaho. 234 pp.

Kelly, L.V. 1913. The Range Men. W. Briggs: Toronto.

Kendall, K.C. 1983. Use of pine nuts by black and grizzly bears in the Yellowstone area. Int. Conf. on Bear Res. and Manage. 5: 166-173.

King, R. 1978. Habitat use and related behaviors of breeding long-billed curlews. M.Sc. Thesis, Colorado State University. Fort Collins, CO.

Kirk, D.A. 1996. Updated status report on the golden eagle, *Aquila chrysaetos*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 17 pp.

Kirk, D.A. and U. Banasch. 1996. Updated status report on the prairie falcon, *Falco mexicanus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 8 pp.

Kirk, D.A. and C. Hyslop. In Press. Population status and recent trends in Canadian raptors: A review. Biol. Conserv.

Kolar, B. and A. Brawn (eds.). 1986. Eastern Slopes Wildlands: our living heritage. Alberta Wilderness Association. Calgary, AB.

Kufeld, R.C. 1973. Foods eaten by the Rocky Mountain elk. J. Range Manage. 26(2): 106-113.

Lacate, D.S. 1969. Guidelines for biophysical land classification. Publ. # 1264. Canadian Forestry Service. Ottawa, ON.

Leary, R.F., F.W. Allendorf, and K.L. Knudson. 1985. Developmental instability as an indicator of reduced genetic variation in hatchery trout. Trans. of the Amer. Fish. Soc. 114: 230-235.

Lefranc, M.N., M.B. Moss, K.A. Patnode, and W.C. Suggs (eds). 1987. *Grizzly Bear Compendium*. Interagency Grizzly Bear Committee. National Wildlife Federation. Washington, DC. 540 pp.

Leskiw, L.A. 1993. Physical land classification of the Upper Bob Creek Ecological Reserve. Prepared for Resource Information Branch, Land Information Services Division, Alberta Environmental Protection by Can-Ag Enterprises Ltd.

Longley, R.W. 1967. The frequency of winter chinooks in Alberta. Atmosphere 5:4-16. *cited in:* Duffy, R.G.Q. 1971. An ecological study of vegetation change in the northern Porcupine Hills, Alberta. M.A. Thesis. Dept. of Geography, University of Calgary, Calgary, Alberta.

Lupton, F.A. 1967. Cattle ranching in Alberta 1874-1910, its evolution and migration. Alberta Geographer 3:48-58.

MacArthur, R.H. and J.W. MacArthur. 1961. On bird species diversity. Ecology 42: 594-598.

MacLennan, R. 1974. Reasons for the decline in moose populations in Saskatchewan. 10th N. Amer. Moose Conf. and Wkshp.: 63-75.

Magoun, A.J. 1985. Population characteristics, ecology, and management of wolverines in northwestern Alaska. Ph.D. Thesis. University of Alaska. Fairbanks, AK.

Malouf, C. and S. Conner (eds.). 1962. Symposium on Buffalo Jumps. Montana Archaeology Society Memorandum No. 1.

Marnell, L.F. 1988. Status of the cutthroat trout in Glacier National Park, Montana. Amer. Fish. Soc. Symp. 4: 61-70.

Mattson, D.J. and C. Jonkel. 1990. Stone pines and bears. Pages 223-236 in: Schmidt, W.C. and K.J. McDonald (comp.) *Proc. - Symp. on Whitebark Pine Ecosystems: Ecology and Manage. of a High Mountain Resource*. United States Department of Agriculture, Intermountain Research Station. Ogden, UT.

McFetridge, R.J. 1985. Wapiti in the Peace River Region: Limit of the species' range. Pages 196-205 in: Nelson, R.W. (ed). *Proc. of the 1984 Western States and Provinces Elk Wkshp*. Alberta Fish and Wildlife Division. Edmonton, AB.

McLellan, B.N. 1992. Current status and long-term threats to grizzly bears in British Columbia. Pages 111-122 in: Rautio, S. (ed). *Community Action for Endangered Species*. British Columbia Ministry of Environment, Lands and Parks and University of British Columbia. Vancouver, BC.

Morgantini, L.E. and W.B. Russell. 1983. An assessment of three selected elk winter ranges in the Rocky Mountain Region. Prepared by Wildland Resource Consultants Ltd. for Alberta Fish and Wildlife Division. Edmonton, AB. 265 pp.

Moss, E.H. 1983. Flora of Alberta. Second edition. Revised by J.G. Packer. University of Toronto Press: Toronto.

Nagy, J.A. and J.R. Gunson. 1990. Management plan for grizzly bears in Alberta. Wildlife Management Planning Series No. 2. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB. 164 pp.

Nelson, J.S. and M.J. Paetz. 1992. *The Fishes of Alberta*. University of Alberta Press. Edmonton, AB. 437 pp.

Newbury, R.W. and M.N. Gaboury. 1993. *Stream Analysis and Fish Habitat Design: A Field Manual*. Newbury Hydraulics Ltd. and Manitoba Department of Natural Resources. Winnipeg, MB. 256 pp.

Nietfeld, M.T. 1983. Foraging behavior of wapiti in the boreal mixedwood forest of central Alberta. M.Sc. Thesis. University of Alberta. Edmonton, AB.

Nietfeld, M., J. Wilk, K. Woolnough, and B. Hoskin. 1984. Wildlife habitat requirement summaries for selected wildlife species in Alberta. Alberta Energy and Natural Resources, Fish and Wildlife Division. Edmonton, AB. var. pp.

Noble, D.G., J.E. Elliot, and J.L. Shutt. 1993. Environmental contaminants in Canadian raptors, 1965-1989. Tech. Rep. Ser. No. 91. Canadian Wildlife Service. Ottawa, ON.

Nowicki, J.J. (ed.). 1973. Livingstone Drainage District - Phase 1. Forest Land Use Branch, Alberta Forest Service.

Ogilvie, R.T. 1990. Distribution and ecology of whitebark pine in western Canada. Pages 54-60 in: Schmidt, W.C. and K.J. McDonald (comp.) *Proc. - Symp. on Whitebark Pine Ecosystems: Ecology and Manage. of a High Mountain Resource*. United States Department of Agriculture, Intermountain Research Station. Ogden, UT.

Ohanjanian, I.A. 1987. Status report and management recommendations for the long-billed curlew (*Numenius americanus*) on the Junction. British Columbia Ministry of Environment, Lands and Parks, Wildlife Branch. Williams Lake, BC. 24 pp.

O'Leary, D., J. Bentz and E. Anderson. 1989. Bob Creek elk winter range habitat study. Publ. No. T/198. Resource Information Branch, Land Information Services Division, Alberta Forestry, Lands and Wildlife. Edmonton, AB.

Palmer, R.S. 1988. Golden eagle. Pages 180-231 in: *Handbook of North American Birds. Vol. 5: Diurnal Raptors*. Yale University Press. New Haven, CT.

Pampush, G.J. 1980. Breeding chronology, habitat utilization, and nest-site selection of the long-billed curlew in northcentral Oregon. M.Sc. Thesis. Oregon State University. Corvallis, OR. 49 pp.

Pampush, G.J. and R.G. Anthony. 1993. Nest success, habitat utilization and nest-site selection of long-billed curlews in the Columbia Basin, Oregon. Condor 95: 957-967.

Paquet, P.C. 1993. Summary reference document: Ecological studies of recolonizing wolf populations in the Central Canadian Rocky Mountains. Prepared by John Paul & Associates for Canadian Parks Service, Banff National Park. Banff, AB. 118 pp.

Paquet, P.C. and A. Hackman. 1995. Large carnivore conservation in the Rocky Mountains. World Wildlife Fund Canada. Toronto, ON. 52 pp.

Paton, P.W.C. and J. Dalton. 1994. Breeding ecology of long-billed curlews at Great Salt Lake, Utah. Great Basin Naturalist 54(1): 79-85.

Pawlina, M. 1997. Personal communication. GISmo Solutions Ltd., Edmonton, Alberta.

Pawluk, S., T.W. Peters and J. Carson. 1966. Soils of the Porcupine Hills region of Alberta. Canadian Journal of Soil Science 48:77-78.

Peek, J.M., D.L. Urich, and R.J. Mackie. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildl. Monogr. 48. 65 pp.

Petit, D.R., J.F. Lynch, R.L. Hutto, J.G. Blake, and R.B. Waide. 1993. Management and conservation of migratory landbirds overwintering in the neotropics. Pages 70-92 in: Finch, D.M. and P.W. Stangel (eds). *Status and Management of Neotropical Migratory Birds*. Gen. Tech. Rep. RM-229. United States Department of Agriculture, Forest Service. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Pettapiece, W.W. 1986. Physiographic subdivisions of Alberta. Map. Published by Land Resource Research Centre, Research Branch, Agriculture Canada, Ottawa.

Picton, H.D. 1979. The application of insular biogeographic theory to the conservation of large mammals in the northern Rocky Mountains. Biol. Conserv. 15: 73-79.

Pinel, H.W., W.W. Smith, and C.R. Wershler. 1991. Alberta birds, 1971-1980. Volume I: Non-passerines. Natural History Occasional Paper No. 13. Provincial Museum of Alberta. Edmonton, AB.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 in: Howell, P.J. and D.V. Buchanan (eds). *Proc. of the Gearhart Mountain Bull Trout Wkshp*. American Fisheries Soc. Oregon Chapter. Corvallis, OR.

Prescott, D.R.C. and D.M. Collister. 1993. Characteristics of occupied and unoccupied loggerhead shrike territories in southeastern Alberta. J. Wildl. Manage. 57(2): 346-352.

Quigley, H., G.M. Koehler, and M.G. Hornocker. 1990. Dynamics of a mountain lion population in central Idaho over a 20-year period. In: *Proc. of the 3rd Mountain Lion Wkshp*. The Wildlife Society. Phoenix, AZ.

Quinn, M.S. 1991. Conservation of herpetofauna in the Prairie Provinces. Pages 197-198 in: Holroyd, G.L., G. Burns, and H.C. Smith (eds). *Proc. of the 2nd Endang. Species and Prairie Conserv. Wkshp*. Nat. Hist. Occ. Paper No. 15. Provincial Museum of Alberta. Edmonton, AB.

Racey, G.D. and D.L. Euler. 1983. Changes in mink habitat and food selection as influenced by cottage development in central Ontario. J. Appl. Ecol. 20(2): 387-402.

Radford, D.S. 1075. Oldman River Flow Regulation Proposal. A preliminary study on the fish resources. Fish and Wildlife Division, Dept. Of Recreation, Parks and Wildlife, Lethbridge, AB.

Raleigh, R.F. and D.A. Duffy. 1981. Trout stream habitat improvement: Ecology and management. Pages 67-77 in: King, W. (ed). *Proc. Wild Trout Symp. II.* Yellowstone National Park, WY.

Redmond, R.L. and D.A. Jenni. 1986. Population ecology of the long-billed curlew (*Numenius americanus*) in western Idaho. Auk 103: 755-767.

Reese, K.P. and J.D. Hair. 1976. Avian species diversity in relation to beaver pond habitats in the Piedmont Region of South Carolina. Pages 437-447 in: *Proc. of the 30th Annual Conf. of the SE Assoc. of Fish and Wildl. Agencies*. Denver, CO.

Reid, D.G. 1984. Ecological interactions of river otters and beavers in a boreal ecosystem. M.Sc. Thesis. University of Calgary. Calgary, AB.

Renaud, W.E. 1980. The long-billed curlew in Saskatchewan: status and distribution. Blue Jay 38: 221-237.

Renecker, L.A. and R.J. Hudson. 1992. Morphology, bioenergetics, and resource use. Pages 187-214 in: Stelfox, J.B. (ed). *Alberta's Hoofed Mammals: Their Ecology, Status and Management*. Lone Pine Press. Edmonton, AB.

Rieman, B.E. and K.A. Apperson. 1989. Status and analysis of salmonid fisheries: Westslope cutthroat trout synopsis and analysis of fishery information. Job Performance Report, Project F-73-R-11. Idaho Department of Fish and Game. Boise, ID.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. Gen. Tech. Rep. INT-302. United States Department of Agriculture. Intermountain Research Station. Ogden, UT.

Ringelman, J.K. 1991. Managing beaver to benefit waterfowl. Fish and Wildlife Leaflet 13.4.7. Waterfowl Management Handbook. United States Fish and Wildlife Service. Washington, DC.

Roberts, W.E. 1987. The bull trout - endangered in Alberta. Pages 129-131 in: Holroyd, G.L., P.H.R. Stepney, G.C. Trottier, W.B. McGillivray, D.M. Ealey, and K.E. Eberhart (eds). *Endangered Species in the Prairie Provinces*. Nat. Hist. Occ. Paper No. 9. Provincial Museum of Alberta. Edmonton, AB.

Roberts, W.E. 1991. The bull trout: Vanishing from the prairie and parkland of western Alberta. Page 196 in: Holroyd, G.L., G. Burns, and H.C. Smith (eds). *Proc. of the 2nd Endang. Spec. and Prairie Conserv. Wkshp*. Nat. Hist. Occ. Paper No. 15. Provincial Museum of Alberta. Edmonton, AB.

Robbins, C.S., D. Bystrak, and P.H. Geissler. 1986. The breeding bird survey: Its first fifteen years. Resource Publ. No. 157. United States Department of the Interior, Fish and Wildlife Service. Washington, DC.

Robertson, A. and B.W. Adams. 1990. Two worksheets for range vegetation monitoring. Range Notes, Issue No. 8. Public Lands Division, Alberta Forestry, Lands and Wildlife. Publ. No. T/207.

Ross, P.I. and M.G. Jalkotzy. 1992. Characteristics of a hunted population of cougars in southwestern Alberta. J. Wildl. Manage. 56: 417-426.

Roy, L.D., J.B. Stelfox, and J.W. Nolan. 1995. Relationships between mammal biodiversity and stand age and structure in aspen mixedwood forests in Alberta. Pages 159-189 in: Stelfox, J.B. (ed). *Relationships Between Stand Age, Stand Structure, and Biodiversity in Aspen Mixedwood Forests in Alberta*. AECV95-R1. Alberta Environmental Center. Vegreville, AB.

Rusch, D.A. and W.G. Reeder. 1978. Population ecology of Alberta red squirrels. Ecology 59: 400-420.

Russell, A.P. and A.M. Bauer. 1993. *The Amphibians and Reptiles of Alberta*. University of Alberta Press. Edmonton, AB. 264 pp.

Salt, W.R. and J.R. Salt. 1976. *The Birds of Alberta With Their Ranges in Saskatchewan and Manitoba*. Hurtig Publishers. Edmonton, AB.

Salt, W.R. and C. Wershler. 1975. A range and elevation extension for the sagebrush vole in Alberta. Can. Field-Nat. 89: 184.

Scott, L. 1991. Balanced land use - agriculture and wildlife. Pp. 109-111 in: *Proceedings of the Second Endangered Species and Prairie Conservation Workshop*. Prov. Mus. Alberta. Nat. Hist. Occ. Pap. No. 15. Edmonton, AB.

Seburn, D. 1993. Handbook for monitoring the amphibians of Alberta. Alberta Environmental Protection, Fish and Wildlife Division. Edmonton, AB. 64 pp.

Semenchuk, G.P. 1992. *The Atlas of Breeding Birds of Alberta*. Federation of Alberta Naturalists. Edmonton, AB. 391 pp.

Shouesmith, I.H. 1972. An analysis of vegetation response to climate on ridgetops in southwest Alberta. M.Sc. Thesis. Department of Geography, University of Calgary, Calgary, Alberta.

Skovlin, J.M. 1982. Habitat requirements and evaluations. Pages 369-414 in: Thomas, J.W. and D.E. Toweill (eds). *Elk of North America: Ecology and Management*. The Wildlife Institute. Washington, DC.

Smith, H.C. 1993. *Alberta Mammals: An Atlas and Guide*. Provincial Museum of Alberta. Edmonton, AB. 238 pp.

Smith, K. 1985. A preliminary elk management plan for the Edson Wildlife Management Area. Alberta Energy and Natural Resources, Fish and Wildlife Division. Edson, AB.

Spreadbury, B. 1988. Cougar ecology and related management implications and strategies in southeastern British Columbia. M.D.P. Thesis. University of Calgary. Calgary, AB. 75 pp.

Squires, J.R., S.H. Anderson, and R. Oakleaf. 1993. Home range size and habitat use patterns of nesting prairie falcons near oil developments in northeastern Wyoming. J. Field Ornithol. 64: 1-10.

Stalker, A. 1953. Surficial geology of southwestern Alberta. Alberta Society of Petroleum Geologists. Third Annual Field Conference Guidebook. pp. 14-22.

Stalker, A. 1962. Surficial geology, Fernie (east half), Alberta and British Columbia. Geological Survey of Canada. Map 31-1961.

Stelfox, J.B., L. Peleshok, and M.T. Nietfeld. 1991. A selected bibliography of research, management, and biology of Alberta's native ungulates. AECV92-B1. Alberta Environmental Center. Vegreville, AB. 110 pp.

Stelfox, J.B. and J.G. Stelfox. 1992. Distribution. Pages 57-76 in: Stelfox, J.B. (ed). *Alberta's Hoofed Mammals: Their Ecology, Status, and Management*. Lone Pine Press. Edmonton, AB.

Stelfox, J.G. 1964. Elk in northwest Alberta. Land-Forest-Wildl. Bull. 6(5): 14-23.

Strong, W.L. 1992. Ecoregions and ecodistricts of Alberta. Alberta Forestry, Lands and Wildlife. Publication T/244.

Sugden, J.W. 1933. Range restriction of the long-billed curlew. Condor 35: 3-9.

Tajek, J., W.W. Pettapiece and K.E. Toogood. 1985. Water erosion potential of soils in Alberta: estimates using a modified USLE. Agriculture Canada, Research Branch. Technical Bulletin No. 1985-29, Ottawa.

Telfer, E.S. 1992. Habitat change as a factor in the decline of the western Canadian loggerhead shrike population. Can. Field-Nat. 106(3): 321-326.

Thiollay, J.M. 1992. Influence of selective logging on bird species diversity in a Guianan rain forest. Conserv. Biol. 6: 47-63.

Thomas, M.K. 1953. Climatological atlas of Canada. N.R.C. No. 3151. *cited in:* Duffy, R.G.Q. 1971. An ecological study of vegetation change in the northern Porcupine Hills, Alberta. M.A. Thesis. Dept. of Geography, University of Calgary, Calgary, Alberta.

Timken, R.L. 1969. Notes on the long-billed curlew. Auk 86: 750-751.

Todd, A.W. and G.M. Lynch. 1992. Managing moose in the 1990s and beyond: Results of a survey of opinions, attitudes, and activities of Alberta's resident moose hunters. Occ. Paper No. 8. Alberta Forestry, Lands and Wildlife; Fish and Wildlife Division. Edmonton, AB.

Trann, K. 1974. Short-eared owls near Edmonton, 1970-1973. Blue Jay 32(3): 148-153.

United States Army Corps of Engineers. 1962. Pavement design for frost conditions. Engineering Manual 1110-1-306.

USDI (United States Department of Interior). 1979. Snake River birds of prey special research report. United States Department of Interior, Bureau of Land Management. Boise, ID. 141 pp.

Usher, R. 1977. Effects of forest clearing on browse production and use in the Sand River area, Alberta. 13th N. Amer. Moose Conf. and Wkshp.: 1-12.

Wagner, W.P. 1966. Correlation of Rocky Mountain and Laurentide glacial chronologies in southwest Alberta, Canada. Unpubl. Ph.D. thesis. University of Michigan.

Wallis, C. 1994. An environmental assessment of the Amoco Hunter Creek exploration well (10-18-11-2-W5M). Prepared by Cottonwood Consultants Ltd. for The Whaleback Coalition, Maycroft, AB.

Wallis, C. 1980. Montane, foothills parkland and southwest rivers: natural landscapes survey 1978-79. Resource Assessment and Management Section, Alberta Parks Division, Alberta Recreation and Parks.

Willoughby, M.G., M. Alexander and K. Sundquist. 1996. Range plant community types and carrying capacity for the Montane Subregion (Montane Ecoregion). Second approximation. Lands and Forest Services, Alberta Environmental Protection. Edmonton, AB.

Willoughby, M.G. and D. Smith. 1996. Range plant community types and carrying capacity for the Subalpine and Alpine Subregions. First approximation. Lands and Forest Services, Alberta Environmental Protection. Edmonton, AB.

Wishart, W.D. 1958. The bighorn sheep of the Sheep River valley. M.Sc. Thesis. University of Alberta. Edmonton, AB.

Woodsworth, G. and K. Freemark. 1981. Status report on the prairie falcon, Falco mexicanus, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

WWFC (World Wildlife Fund Canada). 1988. Prairie conservation action plan. World Wildlife Fund. Toronto, ON.

Young, M.K. (ed). 1995. Conservation assessment for inland cutthroat trout. Gen. Tech. Rep. RM-GTR-256. USDA Forest Service. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 61 pp.

APPENDICES

APPENDIX A

FROST DESIGN CLASSIFICATION

Adapted from United States Army Corps of Engineers (1962) and Greenlee (1981)

Potential Forest Action	Frost Group	Kind of Soil	% by weight, finer than 0.02 mm	Typical Soil Types (USCS)	Typical Soil Textures (CSSC)
Low	F1	Gravelly soils	3-10	GW,GP,GW-GM,GP-GM	g
	F2	Gravelly soils	10-20	GM,GW-GM,GP-GM	g,gL
		sands	3-15	SW,SP,SM,SW-SM,SP-SM	S,fS,cS
Moderate	F3	Gravelly soils	over 20	GM,GC	gL,gC
		Sands except very fine silty sands	over 15	SM,SC	LS
		Clays, P.I. >12	-	CL,CH	C,SiC,L
High	F4	All silts	-	ML,MH	Si,SiL,SiC
		Very fine silty sands	over 15	SM	fSI,vfS
		Clays P.I.>12	-	CL,CL-ML	SC, SiCL
		Varved clays and other fine grained, banded sediments	-	CL & ML; CL,ML &SM; CL,CH &ML; CL,CH,ML & SM	L & CL;CL,L &SL;CL,C &L; CL,C,L & SL

APPENDIX B

ROCKINESS CLASSES

Rockiness is recorded as classes based on the percentage of surface occupied by exposed bedrock.

ROCKINESS	SURFACE OCCUPIED BY BEDROCK (%)
Non-rocky (**R0**)	<2
Slightly rocky (**R1**)	2-10
Moderately rocky (**R2**)	10-25
Very rocky (**R3**)	25-50
Exceedingly rocky (**R4**)	50-90

Definitions:

Rocky 0 (R0): Non-rocky land - bedrock exposure covers less than 2 percent of the surface and is more than 100 m apart. There is minor interference with tillage.

Rocky 1 (R1): Slightly rocky land - sufficient bedrock exposures to interfere with tillage but not to make intertilled crops impracticable. Depending on how the pattern affects tillage, rock exposures are roughly 35 - 100 m apart and cover 2 - 10 % of the surface, depending on the pattern.

Rocky 2 (R2): Moderately rocky land - sufficient bedrock exposures to make tillage of intertilled crops impractical, but soil can be worked for hay crops or improved pasture if other soil characteristics are favourable. Rock exposures are roughly 10 - 35 m apart and cover 10 - 25 % of the surface, depending on the pattern.

Rocky 3 (R3): Very rocky land - sufficient rock outcrop to make use of machinery impractical, except for light machinery where other soil characteristics are especially favourable for improved pasture. The land may have some use for wild pasture or forests, depending on other soil

characteristics. Rock exposures or patches of soil covering too thinly over rock for use, are roughly 3.5-10 m apart and cover 25-50 % of the surface, depending on the patterns.

Rocky 4 (R4): Exceedingly rocky land - sufficient rock outcrops (or very thin soil over rock) to make all use of machinery impractical. The land may have some value for poor pasture or forests. Rock outcrops are 3.5 m or less apart and cover 50 - 90 % of the area.

APPENDIX C

SURFACE STONINESS CLASSES [1]

Adapted from Canada Soil Survey Committee (1987)

Stoniness Class	Description
Stony 0 (**S0**)	non-stony phase - very few stones (<0.01 % of surface, stones >30 m apart)
Stony 1 (**S1**)	slightly stony phase - some stones that hinder cultivation slightly or not at all (0.01 - 3 % of surface, stones 10 - 30 m apart)
Stony 2 (**S2**)	moderately stony phase - enough stones to cause some interference with cultivation (0.1 - 3 % of surface, stones 2 - 10 m apart)
Stony 3 (**S3**)	very stony phase - sufficient stones to handicap cultivation seriously; some clearing is required (3-15 % of surface, stones 1-2 m apart)
Stony 4 (**S4**)	exceedingly stony phase - sufficient stones to prevent cultivation until considerable clearing is done (15-50 % of surface, stones 0.1 - 0.5 m apart)
Stony 5 (**S5**)	excessively stony phase - too stony to permit cultivation; boulder or stone pavement (> 50 % of surface, stones <0.1 m apart)

[1] Phases of stoniness are defined on the basis of the percentage of the land surface occupied by fragments coarser than 15 cm in diameter.

APPENDIX D

SHRINK-SWELL POTENTIAL

Adapted from Greenlee (1981)

Shrink-Swell Potential[1]	Soil Texture
Low	g, gL, gC, SL, S, LS, SC, SCL, some CL
Moderate	L, SiL, FSL, some CL
High	C, SiC, SiCL
Very High	organics

[1] Shrink-swell potential estimates the strength of the soil, that is, its ability to withstand applied loads.

APPENDIX E

SIGNIFICANT FLORA OF THE WHALEBACK STUDY AREA

Successful identification of rare plant populations is best accomplished through intensive survey methods designed to achieve this purpose, in contrast to the biophysical survey methodology employed during 1996 field work. During the course of 1996 field study, 6 significant plant species were found in the study area, of which 3 species, *Poa gracillima* (Pacific bluegrass), *Poa nervosa* (Wheeler's bluegrass) and *Hieracium cynoglossoides* (woolly hawkweed), appear to be new records for the study area, and one species known to occur near the study area, *Angelica dawsonii* (yellow angelica) (Alberta Natural Heritage Information Centre 1997), was confirmed within the study area. However, the study area provides habitat for many other significant plant species, as identified by previous researchers in the Whaleback study area and in immediately adjacent areas (e.g. Wallis 1994 and 1980, Downing and Karpuk 1994, Cottonwood Consultants Ltd. 1987, Alberta Natural Heritage Information Centre 1997).

The following species list of significant flora found within the Whaleback study area during 1996 field work, or known to occur in the area from the work of previous researchers, considers those species currently on the *"tracking list"* maintained by the Alberta Natural Heritage Information Centre (ANHIC). The tracking list includes *"elements of high priority because they are rare, endemic, disjunct, in peril or special in some other way."* (ANHIC 1996). Plant species included on this list are ranked with regard to status on a provincial basis as S1, S2, and occasionally S3. The ranking system used by the ANHIC was developed by The Nature Conservancy and is used throughout North America. This system evaluates and ranks elements on their global and provincial status. The ranking is primarily based on the number of occurrences of each species, though other information such as population size and trend, life history, reproductive strategies and current threats are considered when available (ANHIC 1996). Ranks are defined below (ANHIC 1996).

Rank (G=global; S=Alberta)

G1	**S1**	*less than or equal to 5 occurrences or only a few remaining individuals or may be imperiled because some factor of its biology makes it especially vulnerable to extirpation;*
G2	**S2**	*6-20 occurrences or with many individuals in fewer occurrences; or may be susceptible to extirpation because of some factor of its biology;*
G3	**S3**	*21-100 occurrences, may be rare and local throughout its range, or in a restricted range (may be abundant in some locations or may be vulnerable to extirpation because of some factor of its biology);*
G4	**S4**	*apparently secure under present conditions, typically >100 occurrences but may be fewer with many large populations; may be rare in parts of its range, especially peripherally;*

G5	**S5**	*demonstrably secure under present conditions, >100 occurrences, may be rare in parts of its range, especially peripherally;*
GU	**SU**	*status uncertain often because of low search effort or cryptic nature of the element; possibly in peril, unrankable, more information needed;*
GH	**SH**	*historically known, may be relocated in the future.*

Plant species of the Whaleback study area which are included on the ANHIC *tracking list* are outlined below.

Found by Geowest personnel during 1996 field study:

Poa gracillima (Pacific bluegrass) - comprises 1% canopy cover at sites 65 and 73 within the Sub-Alpine Natural Subregion portion of the study area, in subxeric rough fescue/hairy wild rye grasslands with silky perennial lupine subdominant and bearberry as the dominant low shrub. Appears to be a new record for the study area. **Ranking: S2 G4**

Poa nervosa (Wheeler's bluegrass) - comprises between 1 - 5% canopy cover at sites 1, 17, 22, 33, 61 and 81 in Sub-Alpine (False azalea/grouseberry [eSA[1]]) and Montane (Creeping mahonia/white meadowsweet [dMN] and Thimbleberry/pine grass [eMN]) coniferous communities and within a willow thicket. Appears to be a new record for the study area. **Ranking: S2 G5**

Hieracium cynoglossoides (woolly hawkweed) - present as 1% canopy cover at sites 70 and 75 in Sub-Alpine (False azalea/grouseberry [eSA]) pine-dominated communities. Appears to be a new record for the study area. **Ranking: S2 Not yet ranked globally**

Phacelia hastata (silver-leaved scorpionweed) - occurs as 1% canopy cover at site 23 within the Sub-Alpine portion of the study area. The site is a subxeric, bearberry/rough fescue/pine reed grass/hairy wild rye community intergrading to the lodgepole line ecosite phase of the Bearberry (bMN) ecosite. **Ranking: S2 G5**

Additional Flora on Tracking List Known to Occur in the Whaleback Study Area

(from Alberta Natural Heritage Information Centre files 1997. Refer to this source for detailed site information.)

Antennaria luzuloides (silvery everlasting) - **Ranking: S1?** (ranking questionable at this time) **G5**

Aster campestris (meadow aster) - **Ranking: S2 G5**

Camassia quamash v. *quamash* (blue camas) - **Ranking: S2 G5T?** (global rank for this subspecific taxon; rank questionable at this time)

Conimitella williamsii (conimitella) - **Ranking: S2 G3**

Carex raynoldsii (Raynold's sedge) - **Ranking: S2 G5**

Castilleja cusickii (yellow paintbrush) - **Ranking: S2 G4G5**

Phacelia linearis (linear-leaved scorpionweed) - **Ranking: S2 G5**

Plantago canescens (western ribgrass) - **Ranking: S2 G4G5**

Didymodon rigidulus (rigid screw moss) - **Ranking: S2 G5**

As well, the Whaleback study area supports habitat for plant species included on ANHIC's *"watch list"*. The watch list encompasses those species with restricted distributions within Alberta but that are common within their range. Species on this list which were found to occur within the Whaleback study area during 1996 field investigations are summarized below.

Angelica dawsonii (yellow angelica) - confirmed within the study area. Comprises 1% canopy cover at site 72 within the Sub-Alpine Natural Region portion of the study area. Site is a subhydric willow shrubland with willow to 1.3 meters in height. Northern reed grass and sedges are co-dominant; fowl manna grass and tufted hairgrass are present. Forb diversity low. Cattle heavily use this site and similar areas, and monitoring of the site is suggested to ensure populations are not grazed or trampled out. **Ranking: S3 G4**

Osmorhiza occidentalis (western sweet cicely) - found at sites 3, 33 and 39 in the Montane Natural Subregion portion of the study area in subhygric, aspen-dominated communities (Thimbleberry/pine grass [eMN]) and willow thickets [willow to 9 meters in height]), to mesic, Douglas fir-dominated communities (Creeping mahonia/white meadowsweet [dMN). Occurrence within sites can be highly variable, often 1% canopy cover, but can comprise up to 14% canopy cover (e.g. site 3 - a subhygric, aspen-dominated Thimbleberry/pine grass [eMN] community with cow parsnip as the dominant forb). There currently is heavy use by cattle of site 33, and monitoring of the site is recommended to ensure the population is not lost. Cattle use of site 3 is currently low, but the site is easily accessible by cattle, and future use of the site should be periodically checked to maintain the large population which exists at the site. **Ranking: S3 G4G5**

Pinus albicaulis (whitebark pine) - occurs at higher elevations (e.g. 1880 meters above sea level and higher) within the Sub-Alpine portion of the study area, in conjunction with lodgepole pine at relatively lower elevations (False azalea/grouseberry ecosite [eSA]) or with rough fescue/hairy wild rye grasslands at high elevations. Found at sites 65 and 74. **Ranking: S4 G4**

Pinus flexilis (limber pine) - occurs in Montane portions of the study area along ridge crests and upper slopes where bedrock is close to or at the surface, such as along Whaleback Ridge. Usually occurs in conjunction with Douglas fir within the Limber pine/juniper ecosite (aMN) and the Canada buffaloberry/hairy wild rye ecosite (cMN). Found at sites 30, 32, 57 and 91. Individual limber pine trees within the study area have recently been found with ages ranging from approximately 250 to 575 years old (McIntyre 1997). Further studies are warranted to determine the actual extent of old-growth limber pine in the study area. **Ranking: S4 G5**

As well, numerous other plant species on the ANHIC tracking list have been reported in the immediate vicinity of the study area and it is reasonable to assume that further investigations within the Whaleback study area would likely locate these species within the study area itself on sites of similar habitats. These species as determined from Alberta Natural Heritage Information Centre files, are listed below. Detailed site information can be obtained from ANHIC.

Species which occur outside of but in the immediate vicinity of the study area (from Alberta Natural Heritage Information Centre files 1997. Refer to this source for detailed site information.)

Agropyron scribneri (Scribner's wheat grass) - **Ranking: S2 G5**

Artemisia borealis (northern wormwood) - **Ranking: S2 G?** (not yet ranked globally)

Carex platylepis (broad-scaled sedge) - **Ranking: SU G4?** (global ranking questionable at this time)

Epilobium saximontanum - **Ranking: S2 G5**

Erigeron radicatus (dwarf fleabane) - **Ranking: S2 G3**

Lupinus argenteus (silvery perennial lupine) - **Ranking: S2 G5?** (global ranking questionable at this time)

Lupinus lepidus (alpine lupine) - **Ranking: SU G5**

Saxifraga odontoloma (saxifrage) - **Ranking: SU G5**

APPENDIX F

FAUNAL SPECIES ANTICIPATED TO OCCUR IN THE WHALEBACK STUDY AREA

SPECIES		FAUNAL ELEMENT	MANAGEMENT STATUS
MAMMALS			
masked shrew	*Sorex cinereus*	Boreal-Cordilleran	
dusky shrew	*Sorex monticolus*	Cordilleran	
water shrew	*Sorex palustris*	Boreal-Cordilleran	
pygmy shrew	*Sorex hoyi*	Boreal-Cordilleran	
little brown bat	*Myotis lucifugus*	Widespread	
long-eared bat	*Myotis evotis*	Great Basin	
long-legged bat	*Myotis volans*	Great Basin	
silver-haired bat	*Lasionycteris noctivagans*	Widespread	
big brown bat	*Eptesicus fuscus*	Widespread	
hoary bat	*Lasiurus cinereus*	Widespread	
pika	*Ochotona princeps*	Cordilleran	
snowshoe hare	*Lepus americanus*	Boreal-Cordilleran	
least chipmunk	*Tamias minimus*	Boreal-Cordilleran	
yellow pine chipmunk	*Tamias amoenus*	Cordilleran	
yellow-bellied marmot	*Marmota flaviventris*	Cordilleran	
hoary marmot	*Marmota caligulata*	Cordilleran	- yellow (B) listed in Alberta
Richardson's ground squirrel	*Spermophilus richardsoni*	Campestrian	- yellow (A) listed in Alberta
Columbian ground squirrel	*Spermophilus columbianus*	Cordilleran	
golden-mantled ground squirrel	*Spermophilus lateralis*	Cordilleran	
red squirrel	*Tamiasciurus hudsonicus*	Boreal-Cordilleran	
northern flying squirrel	*Glaucomys sabrinus*	Boreal-Cordilleran	- yellow (B) listed in Alberta

northern pocket gopher	*Thomomys talpoides*	Great Basin	
beaver	*Castor canadensis*	Widespread	
deer mouse	*Peromyscus maniculatus*	Widespread	
bushy-tailed wood rat	*Neotoma cinereus*	Cordilleran	
red-backed vole	*Clethrionomys gapperi*	Boreal-Cordilleran	
heather vole	*Phenacomys intermedius*	Boreal-Cordilleran	
meadow vole	*Microtus pennsylvanicus*	Boreal-Cordilleran	
long-tailed vole	*Microtus longicaudus*	Cordilleran	
water vole	*Microtus richardsoni*	Cordilleran	- yellow (B) listed in Alberta
sagebrush vole	*Lagurus curtatus*	Great Basin	
muskrat	*Ondatra zibethicus*	Widespread	
northern bog lemming	*Synaptomys borealis*	Boreal-Cordilleran	
western jumping mouse	*Zapus princeps*	Cordilleran	
porcupine	*Erethizon dorsatum*	Widespread	
coyote	*Canis latrans*	Widespread	
gray wolf	*Canis lupus*	Widespread	
red fox	*Vulpes vulpes*	Widespread	
black bear	*Ursus americanus*	Widespread	
grizzly bear	*Ursus arctos*	Widespread	- status examined by COSEWIC in 1991 and designated as "vulnerable" - blue-listed in Alberta
raccoon	*Procyon lotor*	Widespread	
marten	*Martes americana*	Boreal-Cordilleran	
ermine	*Mustela erminea*	Boreal-Cordilleran	
least weasel	*Mustela nivalis*	Boreal-Cordilleran	
long-tailed weasel	*Mustela frenata*	Widespread	- status reexamined by COSEWIC in 1993 and downgraded from "vulnerable" to "not at risk" - yellow (A) listed in Alberta

mink	*Mustela vison*	Widespread	
wolverine	*Gulo gulo*	Boreal-Cordilleran	- status examined by COSEWIC in 1989 and designated as "vulnerable" - blue-listed in Alberta
badger	*Taxidea taxus*	Widespread	- status examined by COSEWIC in 1979 and determined to be "not at risk" - yellow (A) listed in Alberta
striped skunk	*Mephitis mephitis*	Widespread	
cougar	*Felis concolor*	Widespread	- yellow (B) listed in Alberta
lynx	*Lynx canadensis*	Boreal-Cordilleran	- status examined by COSEWIC in 1989 and determined to be "not at risk" - yellow (B) listed in Alberta
bobcat	*Lynx rufus*	Widespread	- yellow (B) listed in Alberta
elk	*Cervus elaphus*	Widespread	
mule deer	*Odocoileus hemionus*	Widespread	
white-tailed deer	*Odocoileus virginianus*	Widespread	
moose	*Alces alces*	Boreal-Cordilleran	
bighorn sheep	*Ovis canadensis*	Cordilleran	

BIRDS		FAUNAL ELEMENT	MANAGEMENT STATUS
trumpeter swan	*Cygnus buccinator*	Boreal-Cordilleran	- status examined by COSEWIC in 1996 and determined to be "not at risk" - blue-listed in Alberta
common loon	*Gavia immer*	Widespread	
Canada goose	*Branta canadensis*	Widespread	
northern pintail	*Anas acuta*	Widespread	
cinnamon teal	*Anas cyanoptera*	Campestrian	
northern shoveler	*Anas clypeata*	Widespread	
harlequin duck	*Histrionicus histrionicus*	Cordilleran	- yellow (A) listed in Alberta
green-winged teal	*Anas crecca*	Widespread	

mallard	*Anas platyrhynchos*	Widespread	
blue-winged teal	*Anas discors*	Widespread	
ring-necked duck	*Aythya collaris*	Boreal-Cordilleran	
Barrow's goldeneye	*Bucephala islandica*	Cordilleran	
common goldeneye	*Bucephala clangula*	Widespread	
bufflehead	*Bucephalus albeola*	Widespread	
wood duck	*Aix sponsa*	Eastern Forest	
common merganser	*Mergus merganser*	Boreal-Cordilleran	
osprey	*Pandion haliaetus*	Boreal-Cordilleran	- yellow (B) listed in Alberta
bald eagle	*Haliaeetus leucocephalus*	Widespread	- status examined by COSEWIC in 1996 and determined to be "not at risk" - yellow (B) listed in Alberta
northern harrier	*Circus cyaneus*	Widespread	- status examined by COSEWIC in 1993 and determined to be "not at risk" - yellow (A) listed in Alberta
Cooper's hawk	*Accipiter cooperii*	Eastern Forest	- status reexamined by COSEWIC in 1996 and downlisted from "vulnerable" to "not at risk" - yellow (B) listed in Alberta
northern goshawk	*Accipiter gentilis*	Eastern Forest	- yellow (B) listed in Alberta
sharp-shinned hawk	*Accipiter striatus*	Widespread	
Swainson's hawk	*Buteo swainsoni*	Campestrian	- yellow (A) listed in Alberta
red-tailed hawk	*Buteo jamaicensis*	Widespread	
golden eagle	*Aquila chrysaetos*	Great Basin	-status examined by COSEWIC in 1996 and determined to be "not at risk" - yellow (B) listed in Alberta
American kestrel	*Falco sparverius*	Widespread	
merlin	*Falco columbarius*	Widespread	
prairie falcon	*Falco mexicanus*	Great Basin	- status examined by COSEWIC in 1996 and determined to be "not at risk" - yellow (A) listed in Alberta

peregrine falcon	*Falco peregrinus*	Widespread	- status examined by COSEWIC in 1978 and determined to be "endangered" - red-listed in Alberta
sharp-tailed grouse	*Tympanuchus phasianellus*	Widespread	- yellow (A) listed in Alberta
spruce grouse	*Dendragopus canadensis*	Widespread	
blue grouse	*Dendragopus obscurus*	Cordilleran	
ruffed grouse	*Bonasa umbellus*	Widespread	
wild turkey	*Meleagris gallopavo*	introduced	
sora	*Porzana carolina*	Widespread	
sandhill crane	*Grus canadensis*	Widespread	- yellow (B) listed in Alberta
killdeer	*Charadrius vociferus*	Widespread	
spotted sandpiper	*Actitis macularia*	Widespread	
upland sandpiper	*Bartramia longicauda*	Campestrian	- yellow (A) listed in Alberta
long-billed curlew	*Numenius americanus*	Campestrian	- status examined by COSEWIC in 1992 and determined to be "vulnerable" -blue-listed in Alberta
willet	*Catoptrophorus semipalmatus*	Campestrian	- yellow (B) listed in Alberta
marbled godwit	*Limosa fedoa*	Campestrian	
Wilson's phalarope	*Phalatropus tricolor*	Widespread	
common snipe	*Gallinago gallinago*	Widespread	
rock dove	*Columba livia*	introduced	
mourning dove	*Zenaida macroura*	Campestrian	
great horned owl	*Bubo virginianus*	Widespread	
barred owl	*Strix varia*	Boreal-Cordilleran	- yellow (B) listed in Alberta
great gray owl	*Strix nebulosa*	Boreal-Cordilleran	- status reexamined by COSEWIC in 1996 and downlisted from "vulnerable" to "not at risk" - yellow (B) listed in Alberta

short-eared owl	*Asio flammeus*	Campestrian	- status examined by COSEWIC in 1994 and determined to be "vulnerable" - blue-listed in Alberta
long-eared owl	*Asio otus*	Great Basin	
northern pygmy owl	*Glaucidium gnoma*	Boreal Cordilleran	
northern saw-whet owl	*Aegolius acadicus*	Boreal-Cordilleran	
common nighthawk	*Chordeiles minor*	Widespread	
rufus hummingbird	*Selasphorus rufus*	Cordilleran	
calliope hummingbird	*Stellula calliope*	Cordilleran	
black swift	*Cypseloides niger*	Campestrian	- yellow (B) listed in Alberta
belted kingfisher	*Ceryle alcyon*	Widespread	
red-naped sapsucker	*Sphyrapicus nuchalis*	Cordilleran	
downy woodpecker	*Picoides pubescens*	Widespread	
hairy woodpecker	*Picoides villosus*	Widespread	
three-toed woodpecker	*Picoides tridactylus*	Boreal-Cordilleran	
Lewis' woodpecker	*Melanerpes lewis*	Cordilleran	
pileated woodpecker	*Dryocopus pileatus*	Widespread	- yellow (B) listed in Alberta
northern flicker	*Colaptes auratus*	Widespread	
olive-sided flycatcher	*Contopus borealis*	Boreal-Cordilleran	
western wood pewee	*Contopus sordidulus*	Widespread	
willow flycatcher	*Empidonax traillii*	Cordilleran	
dusky flycatcher	*Empidonax oberholseri*	Cordilleran	
alder flycatcher	*Empidonax alnorum*	Widespread	
least flycatcher	*Empidonax minimus*	Widespread	
cordilleran flycatcher	*Empindonax occidentalis*	Campestrian	- yellow (B) listed in Alberta
olive-sided flycatcher	*Contopus borealis*	Widespread	
least flycatcher	*Empidonax minimus*	Widespread	
western kingbird	*Tyrannus verticalis*	Great Basin	

eastern kingbird	*Tyrannus tyrannus*	Widespread	
horned lark	*Eremophila alpestris*	Campestrian	
tree swallow	*Tachycineta bicolor*	Widespread	
violet-green swallow	*Tachycineta thalassina*	Cordilleran	
northern rough-winged swallow	*Stelgidopteryx serripennis*	Great Basin	
bank swallow	*Riparia riparia*	Widespread	
cliff swallow	*Hirundo pyrrhonota*	Widespread	
barn swallow	*Hirundo rustica*	Widespread	
gray jay	*Perisoreus canadensis*	Widespread	
blue jay	*Cyanocitta cristata*	Boreal Cordilleran	
Steller's jay	*Cyanocitta stelleri*	Campestrian	- yellow (B) listed in Alberta
Clark's nutcracker	*Nucifraga columbiana*	Cordilleran	- yellow (B) listed in Alberta
black-billed magpie	*Pica pica*	Widespread	
American crow	*Corvus brachyrhynchos*	Widespread	
common raven	*Corvus corax*	Widespread	
black-capped chickadee	*Parus atricapillus*	Widespread	
mountain chickadee	*Parus gambeli*	Cordilleran	
red-breasted nuthatch	*Sitta canadensis*	Widespread	
white-breasted nuthatch	*Sitta carolinensis*	Eastern Forest	
brown creeper	*Certhia americana*	Boreal Cordilleran	- yellow (B) listed in Alberta
winter wren	*Troglodytes troglodytes*	Boreal Cordilleran	
marsh wren	*Cistothorus palustris*	Widespread	- yellow (B) listed in Alberta
rock wren	*Salpinctes obsoletus*	Great Basin	- yellow (B) listed in Alberta
house wren	*Troglodytes aedon*	Widespread	
American dipper	*Cinclus mexicanus*	Cordilleran	- yellow (B) listed in Alberta
golden-crowned kinglet	*Regulus satrapa*	Boreal-Cordilleran	

ruby-crowned kinglet	*Regulus calendula*	Widespread	
mountain bluebird	*Sialia currucoides*	Great Basin	
western bluebird	*Sialia mexicana*	Campestrian	
Townsend's solitaire	*Myadestes townsendi*	Cordilleran	
veery	*Catharus fuscescens*	Boreal-Cordilleran	
Swainson's thrush	*Catharus ustulatus*	Widespread	
hermit thrush	*Catharus guttatus*	Widespread	
American robin	*Turdus migratorius*	Widespread	
varied thrush	*Ixoreus maevius*	Cordilleran	
gray catbird	*Dumetella carolinensis*	Eastern Forest	
American pipit	*Anthus rubescens*	Cordilleran	
cedar waxwing	*Bombycilla cedrorum*	Widespread	
loggerhead shrike	*Lanius ludovicianus*	Widespread	- status examined by COSEWIC in 1986 and determined to be "threatened" - yellow (B) listed in Alberta
European starling	*Sturnus vulgaris*	introduced	
warbling vireo	*Vireo gilvus*	Widespread	
red-eyed vireo	*Vireo olivaceus*	Widespread	
solitary vireo	*Vireo solitarius*	Widespread	
orange-crowned warbler	*Vermivora celeta*	Widespread	
yellow warbler	*Dendroica petechia*	Widespread	
yellow-rumped warbler	*Dendroica coronata*	Widespread	
Townsend's warbler	*Dendroica townsendi*	Cordilleran	- yellow (B) listed in Alberta
MacGillivray's warbler	*Oporornis tolmiei*	Cordilleran	
common yellowthroat	*Geothlypis trichas*	Widespread	
western tanager	*Piranga ludoviciana*	Widespread	_ yellow (B) listed in Alberta
lazuli bunting	*Passerina amoena*	Cordilleran	

black-headed grosbeak	*Pheuticus melanocephalus*	Cordilleran	
chipping sparrow	*Spizella passerina*	Widespread	
clay-colored sparrow	*Spizella pallida*	Widespread	- yellow (A) listed in Alberta
vesper sparrow	*Pooecetes gramineus*	Widespread	
song sparrow	*Melospiza melodius*	Widespread	
savannah sparrow	*Passerculus sandwichensis*	Widespread	
Lincoln's sparrow	*Melospiza lincolnii*	Widespread	
white-crowned sparrow	*Zonotrichia leucophrys*	Cordilleran	
dark-eyed junco	*Junco hyemalis*	Widespread	
red-winged blackbird	*Agelaius phoeniceus*	Widespread	
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Widespread	
western meadowlark	*Stumella neglecta*	Campestrian	- yellow (A) listed in Alberta
Brewer's blackbird	*Euphagus cyanocephalus*	Widespread	
brown-headed cowbird	*Molothrus ater*	Widespread	
northern oriole	*Icterus galbula*	Eastern Forest	
rosy finch	*Leucosticte arctoa*	Cordilleran	
evening grosbeak	*Coccothraustes vespertinus*	Boreal	
pine grosbeak	*Pinicola enucleator*	Boreal Cordilleran	
Cassin's finch	*Carpodacus cassinii*	Cordilleran	
red crossbill	*Loxia curvivostra*	Cordilleran	
white-winged crossbill	*Loxia leucoptera*	Boreal-Cordilleran	
pine siskin	*Carduelis pinus*	Boreal-Cordilleran	
American goldfinch	*Carduelis tristis*	Campestrian	
house sparrow	*Passer domesticus*	Widespread	

AMPHIBIANS & REPTILES	FAUNAL ELEMENT	MANAGEMENT STATUS

tiger salamander	*Ambystoma tigrinum*	Campestrian	
boreal toad	*Bufo boreas*	Boreal-Cordilleran	
spotted frog	*Rana pretiosa*	Cordilleran	- blue-listed in Alberta
wood frog	*Rana sylvatica*	Widespread	
wandering garter snake	*Thamnophis elegans*	Widespread	- yellow (A) listed in Alberta
red-sided garter snake	*Thamnophis sirtalis*	Widespread	- yellow (A) listed in Alberta

APPENDIX G

PLATES

Plate 1: Camp Creek valley, looking south-west from site 12. Foreground is a M1.1 unit supporting the Rough fescue/Parry oat grass - California oat grass community type which, at this specific site, is dominated by rough fescue (*Festuca scabrella*) and Idaho fescue (*F. idahoensis*). The riparian area of Camp Creek is defined by the F1.1 unit. Lower slopes at middle right of the photo comprise a MR1.1 unit, with VR1.5 represented upslope and in the background. Forested slopes of northerly aspects at middle left consist of MR1.4 units on lower slopes and VR1.1 units on steeper, upper slopes. Riparian habitats in the lower reaches of Camp Creek provide critical moose winter range. The Livingstone Range can be seen in the background.

Plate 2: Low Shrubland community type on an east-facing slope of Whaleback Ridge at site 31. Behind is a Rough fescue/Parry oat grass - California oat grass community type, with Douglas-fir (*Pseudotsuga menziesii*) and limber pine (*Pinus flexilis*) of the Canada buffaloberry/hairy wild rye ecosite (cMN) in the background at upper left. The Low Shrubland type at this site is dominated by buckbrush (*Symphoricarpos occidentalis*), with wild bergamot (*Monarda fistulosa*), fringed brome (*Bromus ciliatus*) and rough fescue common. Such a site is typical of lower- and mid-slope shrublands which frequently occur on these Montane grassland slopes, and reflect mesic seepage sites with relatively deep soil profiles.

Plate 3: Whaleback Ridge, looking north from site 32. Note the sharp delineation of Douglas-fir and limber pine stands of the Canada buffaloberry/hairy wild rye ecosite (cMN), showing where bedrock strata is at or very near the surface. Also note the high diversity of habitat types present in the relatively small area depicted in the photo, including subhygric, tall willow thickets within the valley bottom, mesic and subxeric rough fescue-dominated grasslands, low shrublands in ephemeral drainages and seeps, aspen stands, open to semi-open Douglas-fir and limber pine stands and closed Douglas-fir stands, all occurring in a complex mosaic. This mosaic lends itself well to use by elk during winters by providing an excellent interspersion of forage and cover resources.

Plate 4: Limber pine on Whaleback Ridge. This individual tree is used by four different species of avifauna for nesting purposes. The study area contains old-growth limber pine, with ages ranging from approximately 250 to 575 years old.

Plate 5: Site 27 within a VR1.6 unit, with a sparse overstorey of limber pine and Douglas-fir. The understorey, dominated by bluebunch wheat grass (*Agropyron spicatum*) and Idaho fescue, represents some of the variation encompassed by the Rough fescue/Parry oat grass - California oat grass community type within the study area on drier, upper-slope grasslands where rough fescue becomes less common. Some logging of limber pine has occurred here in the past.

Plate 6: Old-growth Douglas-fir within the Douglas-fir/feathermoss ecosite phase of the Creeping mahonia - white meadowsweet ecosite (dMN) at site 34 on Whaleback Ridge. The photo depicts the VR1.1 unit as it occurs in the Montane on steep, north-facing slopes which are particularly common on Whaleback Ridge. Cougar markings and sign such as scratchings, diggings, and tracks were seen in these types of stands on Whaleback Ridge during 1996 field investigations.

Plate 7: Younger Douglas-fir with a crown closure greater than 70 percent, also at site 34, showing the variations in ages, crown closure and corresponding differences in understorey biomass productivity and species composition.

Plate 8: Subhygric Aspen community type within a MR1.3 unit at site 3. Cow parsnip (*Heracleum lanatum*) is dominant in the understorey. Subdominant in the understorey is western sweet cicely (*Osmorhiza occidentalis*) at 14% canopy cover. Western sweet cicely is on the *"watch list"* of the Alberta Natural Heritage Information Centre.

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Plate 9: Camp Creek at site 20 within a F1.1 unit. White spruce (*Picea glauca*) and willows (*Salix* spp.) are common on this subhygric site, which represents the Horsetail ecosite (gMN). Such sites are often used by bears in the spring as they provide some early access to succulent forage in the form of *Equisetum* spp. and other species. The rocky substrate of Camp Creek also provides habitat for bull trout and rainbow trout, two species which also make use of overhanging banks and in-stream debris.

Plate 10: Thimbleberry/pine grass Aw ecosite phase of the Thimbleberry/pine grass ecosite (eMN) at site 83 within a VR1.9 unit. Aspen (*Populus tremuloides*) is dominant on this mesic site, with pine reed grass (*Calamagrostis rubescens*) extensive throughout at 80% canopy cover. Note the occasional Douglas-fir regen.

Plate 11: False azalea/grouseberry ecosite (eSA) at site 61 within a VR1.1 unit in the Sub-Alpine portion of the study area. This site is dominated by lodgepole pine (*Pinus contorta*), with false azalea (*Menziesia ferruginea*) the dominant understorey species. Such sites are typical for VR1.1 units as they occur in Sub-Alpine portions of the study area.

Plate 12: Rough fescue/hairy wild rye - smooth brome community type at site 63. Hairy wild rye (*Elymus innovatus*) is dominant here, with rough fescue subdominant and smooth brome occasional. This is a high elevation (2067 meters above sea level) Sub-Alpine grassland within a XR1.2 unit. Whitebark pine (*Pinus albicaulis*) occurs sparsely at the grassland - forest ecotone, with lodgepole pine forming denser canopies downslope. Such a vegetation pattern is typical of these sites. The productive nature of these grasslands provide habitat for bighorn sheep which winter on Sub-Alpine ridges in the area. Grizzly bear use of these habitats, while not quantified to date, is expected to be high in comparison to other areas of the Whaleback.

Plate 13: Upper White Creek at site 71 within a F3.1 unit in the Sub-Alpine portion of the study area. Vegetation patterns are highly variable over short distances. Community types occur with patchy distributions reflecting the wide variation in moisture regimes at micro-sites within the area.

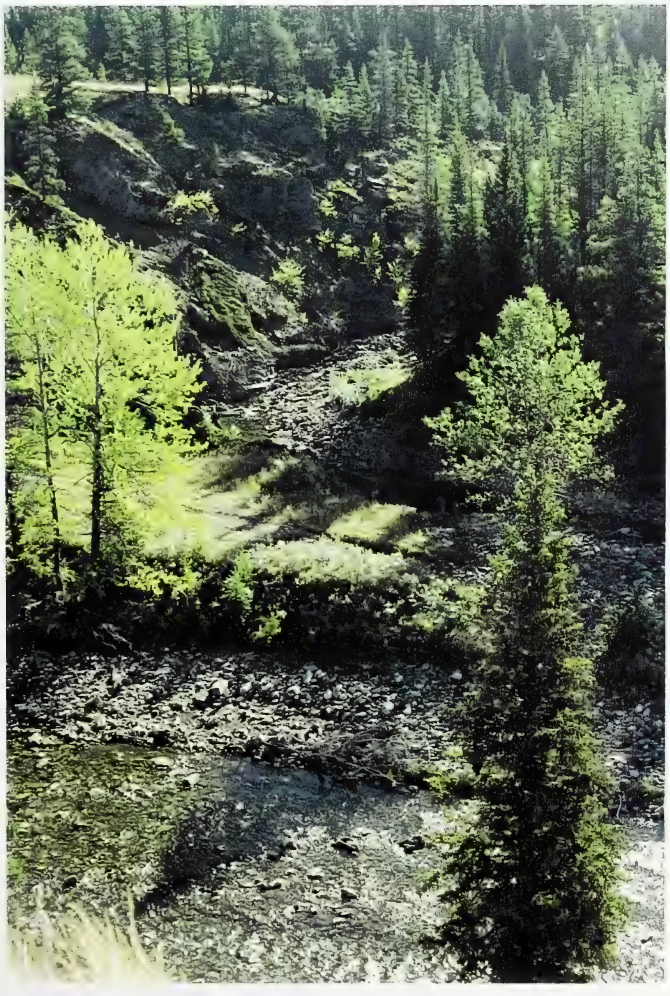

Plate 14: The confluence of White Creek and the Livingstone River. Both of these watercourses are considered high quality trout production waters. In addition, habitat for some semi-aquatic mammals such as mink and, perhaps, river otter is confined largely to such lotic environments. Cliff banks and escarpments also provide potential denning and / or nesting habitats for numerous species such as wolverines, prairie falcons, and golden eagles.

APPENDIX H

WHALEBACK AREA ECOLOGICAL LAND CLASSIFICATION LEGEND

PART 1 and PART 2

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WHALEBACK AREA ECOLOGICAL LAND CLASSIFICATION LEGEND – Part 1

ECOSITE	LANDFORM AND SURFICIAL MATERIALS	VEGETATION	SOIL CLASSIFICATION	SLOPE (%)	DRAINAGE CLASS	SURFACE TEXTURE	SUBSURFACE TEXTURE
COLLUVIUM							
C1.1	Colluvial aprons or fans, often at base of rock faces; active deposition	*Generally unvegetated.*	Orthic Regosol, nonsoil	31 - 70+	Rapidly to Well	rubbly to blocky	rubbly to blocky
C1.2	Colluvial aprons or fans, often at base of steeply inclined bedrock-controlled slopes; active deposition may occur, usually to a lesser degree than for C1.1	*Complex of herbaceous and young deciduous vegetation.* Willow shrubland / Bog birch shrubland; Rough fescue/hairy wild rye - smooth brome / Thimbleberry/pine grass (eMN)	Orthic Regosol	31 - 70+	Rapidly to Well	rubbly to blocky	rubbly to blocky
C1.3	Colluvial aprons or fans, often at base of steeply inclined bedrock-controlled slopes; active deposition generally less frequent than in other C1 units	*Mixed wood forest.* False azalea/grouseberry (eSA); Creeping mahonia/white meadowsweet (dMN)	Orthic Regosol	31 - 70+	Rapidly to Well	rubbly to blocky	rubbly to blocky
C2.1	Slumps consisting of materials of various origin, such as morainal or glaciofluvial material; medium to coarse textured	*Deciduous or coniferous forest.* Thimbleberry/pine grass (eMN); Canada buffaloberry/hairy wild rye (cMN); Willow shrubland; Bog birch shrubland	Orthic Regosol	16 - 70	Well to Imperfectly	sandy loam to sandy clay loam; silty clay loam to clay loam	sandy loam to sandy clay loam; silty clay loam to clay loam
C2.2	Slumps consisting of materials of various origin, such as morainal or glaciofluvial material; medium to coarse textured	*Shrub/grassland with deciduous or coniferous forest patches.* False azalea/grouseberry (eSA) / Rough fescue/hairy wild rye - smooth brome; Bog birch shrubland / Rough fescue/Parry oat grass - California oat grass; Subhygric Aspen	Orthic Regosol	16 - 70	Rapidly to Moderately Well	sandy loam to sandy clay loam; silty clay loam to clay loam	sandy loam to sandy clay loam; silty clay loam to clay loam
C3.1	Fluvial-cut scarp faces consisting of material of various origin, including glaciofluvial, morainal and bedrock material; medium to coarse textured; erosional processes generally active	*Generally unvegetated.*	nonsoil, Orthic Regosol	70+	Rapidly	rubbly; sandy loam to sandy clay loam; silty clay loam to clay loam	rubbly; sandy loam to sandy clay loam; silty clay loam to clay loam

AL.2 2000-27
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FLUVIAL							
F1.1	Active or periodically active floodplains and low terraces of fluvial material adjacent permanent stream channels of rivers and major creeks; mediium to coarse textured; can have buried, thin organic materials; channel deposits are generally excessively stony while bank deposits may be slightly to very stony; includes the Oldman and Livingstone rivers, and Bob, Camp, White, Chaffen and other permanent creeks	*Complexes of shrubs, herbaceous vegetation and coniferous trees.* Rough fescue/Parry oat grass - California oat grass / Creeping mahonia - white meadowsweet; Mesic terrace grassland; Thimbleberry/pine grass (eMN); Horsetail (gMN); Willow thickets; Willow shrubland; Riparian	Cumulic Humic Regosol; Orthic Humic Regosol; Gleyed Cumulic Regosol; Rego Gleysol; Rego Humic Gleysol; Mesic Fibrisol; Terric Fibrisol	0 - 5	Very Poorly to Well	silt to silty clay loam; loamy sand	silt to gravelly silty clay loam; sandy clay loam; fibric to mesic
F2.1	Mappable, inactive or periodically active upper terraces and small fans of fluvial material within drainage valleys of permanent streams	*Grass/forb dominated, scattered to patchy trees and shrubs.* Rough fescue/Parry oat grass - California oat grass / Mesic terrace grasslands	Cumulic Regosol; Orthic Regosol	0 - 5	Well	silt to silty clay loam; loamy sand	silt loam to silty clay loam; sandy clay loam
F2.2	Mappable, inactive or periodically active upper terraces and small fans of fluvial material within drainage valleys of permanent streams; may include small, water-filled oxbows	*Open forest, variable densities though. Usually coniferous-dominated mixed wood. Can have inclusions of F2.3* Rough fescue/Parry oat grass - California oat grass / Thimbleberry pine grass (eMN); Subhygric Aspen; Mesic terrace grasslands	Cumulic Regosol; Gleyed Regosol; Gleyed Cumulic Regosol	0 - 5	Well to Very Poorly	silt to silty clay loam; loamy sand	silt loam to silty clay loam; sandy clay loam
F2.3	Mappable, inactive or periodically active upper terraces and small fans of fluvial material within drainage valleys of permanent streams	*Closed forest. Usually coniferous-dominated mixed wood. May include open patches such as F2.2 inclusions.* Thimbleberry/pine grass (eMN); Horsetail (gMN)	Cumulic Regosol; Orthic Regosol	0 - 5	Well to Moderately Well	silt to silty clay loam; loamy sand	silt loam to silty clay loam; sandy clay loam

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FLUVIAL						
F3.1	Mappable, major, slightly inclined to inclined fluvial fans deposited by ephemeral or permanent streams	*Shrub-dominated, or young deciduous forest.* Bog birch shrubland; Willow shrubland; Thimbleberry/pine grass (eMN)	Cumulic Regosol; Cumulic Humic Regosol; Gleyed Humic Regosol	6 - 15	Well to Imperfectly	silt l loar
F3.2	Mappable, major, slightly inclined to inclined fluvial fans deposited by ephemeral or permanent streams	*Grass-dominated.* Mesic terrace grassland	Cumulic Humic Regosol; Cumulic Regosol	6 - 15	Well to Moderately Well	silt l loar
F4.1	Ephemeral streams; includes defined, periodically active, channels and associated riparian areas	*Vegetation associated with intermittent streams, usually woody - coniferous and deciduous.* Willow thickets; Low shrubland; Subhygric Aspen; Horsetail (gMN); Thimbleberry/pine grass (eMN)	Gleyed Cumulic Humic Regosol; Gleyed Regosol; Rego Humic Gleysol	2 - 100	Imperfectly to Moderately Well	clay clay
F4.2	Ephemeral streams and seeps; includes poorly defined, periodically active channels and associated areas influenced by heightened moisture	*Woody vegetation.* Low shrubland; Willow shrubland / Bog birch shrubland; Subhygric Aspen; Willow thickets	Gleyed Cumulic Humic Regosol; Gleyed Regosol; Rego Humic Gleysol; Gleyed Humic Regosol	2 - 9	Imperfectly to Moderately Well	clay clay
F4.3	Ephemeral streams and seeps; includes poorly defined, periodically active channels and associated areas influenced by heightened moisture	*Herbaceous vegetation.* Sedge meadows; Mesic terrace grasslands	Gleyed Cumulic Humic Regosol; Gleyed Regosol; Rego Humic Gleysol; Gleyed Humic Regosol	2 - 9	Imperfectly to Moderately Well	clay clay

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GLACIOFLUVIAL						
GF1.1	Level to gently inclined terraces of fine to coarse textured glaciofluvial outwash material; may have veneers of recent fluvial materials on lower terraces	*Grasslands.* Rough fescue/Parry oat grass - California oat grass; Western porcupine grass and Columbia needle grass / Mesic terrace grasslands	Rego Black Chernozem; Orthic Black Chernozem; Calcareous Black Chernozem	0 - 15	Rapidly to Moderately Well	silt lo loam
GF1.2	Level to gently inclined terraces of fine to coarse textured glaciofluvial outwash material; may have veneers of recent fluvial materials on lower terraces	*Woody vegetation.* Bearberry (bMN); Creeping mahonia - white meadowsweet (dMN); Subhygric Aspen; Willow shrubland	Eluviated Black Chernozem; Orthic Eutric Brunisol; Gleyed Eluviated Black Chernozem	0 - 15	Rapidly to Imperfectly	silt lo loam
GF1.3	Level to gently inclined terraces of medium to coarse textured glaciofluvial outwash material; may have veneers of recent fluvial materials on lower terraces; shallow organic deposits or mineral soils of heightened moisture are common	*Grasses, sedges, deciduous shrubs e.g. willows, bog birch.* Mesic terrace grasslands; sedge meadows; Willow shrubland; Bog birch shrubland	Humic Rego Gleysol	0 - 15	Poorly to Moderately Well	silt lo loam
GF2.1	Inclined, steep terrace scarps of medium to coarse textured glaciofluvial outwash material	*Grass-dominated. May have inclusions of aspen.* Rough fescue/Parry oat grass - California oat grass; Low shrubland	Rego Black Chernozem	31 - 70 +	Rapidly to Well	silt lo loam loam
GF2.2	Inclined, steep terrace scarps of medium to coarse textured glaciofluvial outwash material	*Woody vegetation.* Thimbleberry/pine grass (eMN); Canada buffaloberry/hairy wild rye (cMN); Creeping mahonia -	Rego Black Chernozem; Eluviated Black Chernozem; Orthic Dark Gray Chernozem; Orthic Eutric Brunisol	31 - 70+	Rapidly to Well	silt lo loam loam

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GF3.2	Eskers; medium to coarse textured glaciofluvial material; ridged; occur in the Oldman River and White Creek valleys	*Woody vegetation, usually lodgepole pine forest.* False azalea/grouseberry (eSA); Creeping mahonia/white meadowsweet (dMN)	Orthic Eutric Brunisol	31 - 70+	Rapidly to Well	silty san grav
GF4.1	Pitted terraces of ice-contact glaciofluvial material; medium to coarse textured	*Grass-dominated.* Rough fescue/Parry oat grass - California oat grass; Mesic terrace grasslands	Rego Black Chernozem; Orthic Black Chernozem; Calcareous Black Chernozem	0 - 70+	Well to Moderately Well	silt l loar
GLACIOLACUSTRINE						
GL1.1	Level to slightly inclined glaciolacustrine deposits in the vicinity of Chaffen Creek	*Grassland, mesic to subhygric.* Rough fescue/Parry oat grass - California oat grass / mesic terrace grasslands	Orthic Black Chernozem	0 - 9	Well to Imperfectly	silt l loar
MORAINE						
M1.1	Level to inclined to undulating morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Grassland; shrub patches in depressions.* Rough fescue/Parry oat grass - California oat grass; Willow shrubland; Willow thickets; Low shrubland	Orthic Black Chernozem; Solonetzic Black Chernozem	0 - 15	Well to Imperfectly; Imperfectly to Poorly drained in depressions in hummocky topography	silt l loar
M1.2	Level to inclined to undulating morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Deciduous forest; grassland inclusions.* Thimbleberry/pine grass (eMN);	Eluviated Black Chernozem; Orthic Dark Gray Chernozem; Orthic Black Chernozem	0 - 15	Well to Imperfectly	silt l loar

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M1.3	Level to inclined to undulating morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Closed mixed wood; grassland inclusions.* Creeping mahonia - white meadowsweet (dMN) / Thimbleberry/pine grass (eMN); Rough fescue/Parry oat grass - California oat grass	Eluviated Black Chernozem; Orthic Dark Gray Chernozem; Orthic Black Chernozem; Gleyed Eluviated Black Chernozem	0 - 15	Well to Imperfectly	silt loa
M1.4	Level to inclined to undulating morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Closed coniferous forest.* Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN)	Orthic Eutric Brunisol; Orthic Dark Gray Chernozem; Eluviated Black Chernozem; Gleyed Eutric Brunisol	0 - 15	Well to Imperfectly	silt loa
M1.5	Level to inclined, undulating to hummocky morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Grassland with minor occurrence of deciduous forest patches.* Rough fescue/Parry oat grass - California oat grass; Thimbleberry/pine grass (eMN)	Orthic Black Chernozem; Eluviated Black Chernozem; Gleyed Eluviated Black Chernozem	0 - 15	Well to Imperfectly	silt loa
M1.6	Level to inclined to undulating morainal deposits commonly occurring in bottomland areas as blankets over bedrock; somewhat moister than M1.1, reflected in the vegetation of the unit	*Moist grasslands with forbs and shrubs.* Mesic terrace meadows; Rough fescue/Parry oat grass - California oat grass; Willow shrubland / Bog birch shrubland; Sedge meadows; Low shrubland	Orthic Black Chernozem; Gleyed Black Chernozem; Orthic Humic Gleysol	0 - 15	Moderately Well to Imperfectly	silt loa
M1.7	Level to inclined to undulating morainal deposits commonly occurring in	*Shrublands.*	Orthic Black Chernozem; Gleyed Black Chernozem;	0 - 15	Moderately Well to Imperfectly	silt loa

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M1.9	Level to inclined morainal deposits commonly occurring in bottomland areas as blankets over bedrock	*Tame pasture.* Anthropogenic	Orthic Black Chernozem	0 - 15	Well to Moderately Well	silt l loam
MORAINAL VENEERS OVER BEDROCK						
MR1.1	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Grassland, sometimes with deciduous inclusions.* Rough fescue/Parry oat grass - California oat grass; Western porcupine grass and Columbia needle grass; Low shrubland	Orthic Black Chernozem; Rego Black Chernozem; Solonetzic Black Chernozem	0 - 45	Well to Moderately Well	silty sand
MR1.2	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges; somewhat moister than MR1.1, reflected in the vegetation of the unit, generally due to northerly and easterly aspects typical of the unit	*Moist grassland, more forbs, some shrubs possible.* Mesic terrace grasslands; Rough fescue/Parry oat grass - California oat grass; Low shrubland	Orthic Black Chernozem	0 - 45	Well to Moderately Well	silty sand
MR1.3	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges; localized moist depressional	*Deciduous forest; grassland openings common where topography is variable, creating a mosaic of forest and openings in such areas.* Thimbleberry/pine grass (eMN); Horsetail (gMN); Bog birch	Orthic Black Chernozem; Rego Black Chernozem; Orthic Dark Gray Chernozem; Eluviated Black Chernozem; Orthic Humic Gleysol	0 - 45	Well to Imperfectly	silty sand

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MR1.4	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Mixed wood forest.* Creeping mahonia - white meadowsweet (dMN); Thimbleberry/pine grass (eMN); Canada buffaloberry/hairy wild rye transition - creeping mahonia/white meadowsweet (c/dMN)	Brunisolic Gray Luvisol; Orthic Dark Gray Chernozem; Orthic Eutric Brunisol	0 - 45	Well to Imperfectly	silty san
MR1.5	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Coniferous forest; deciduous inclusions.* Creeping mahonia/white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN); False azalea/grouseberry (eSA)	Orthic Eutric Brunisol; Brunisolic Gray Luvisol	0 - 45	Well to Imperfectly	silty san
MR1.6	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges; occasional seeps	*Shrublands, seeps; can be young to mature deciduous trees in patches amid moist grassland.* Sedge meadows; Mesic terrace grasslands; Subhygric Aspen; Willow shrubland / Bog birch shrubland	Orthic Black Chrenozem; Gleyed Black Chernozem; Orthic Humic Gleysol	0 - 45	Moderately Well to Poorly	silty san
MR1.7	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs along lower slopes of Whaleback Ridge and other major ridges, as a transitional area	*Deciduous forest and grassland mosaic of generally equal amounts, with conifer inclusions possible on north aspects.*	Eluviated Black Chernozem; Orthic Black Chernozem; Rego Black Chernozem; Gleyed Eluviated Black	0 - 45	Well to Imperfectly	silty san

AL.2.2000-27
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MR1.8	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occurs in Sub-Alpine along lower slopes of major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Conifer and minor grasslands, forming a mosaic, especially in Sub-Alpine on lower slopes leading to drainages.* False azalea/grouseberry (eSA) // Rough fescue/Parry oat grass - California oat grass; Creeping mahonia/white meadowsweet // Forb meadows	Orthic Eutric Brunisol; Orthic Black Chernozem	0 - 45	Well to Moderately Well	silty sand
MR1.9	Inclined, undulating to rolling morainal veneers and thin blankets over bedrock; generally occur along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Tame forage.* Anthropogenic	Orthic Black Chernozem	0 - 45	Well to Moderately Well	silty loam
MR2.1	Dissected, or rolling to ridged morainal veneers and thin blankets over bedrock; generally occur along lower slopes of Whaleback Ridge and other major ridges, as a transitional area between bottomlands and the VR1 units which comprise the majority of the ridges	*Conifer-dominated with numerous grassland openings along flanks of ridge "ribs" in eastern portions of the study area. A mosaic.* Canada buffaloberry/hairy wild rye (cMN) / Creeping mahonia - white meadowsweet (dMN) / Rough fescue/Parry oat grass - California oat grass	Orthic Eutric Brunisol; Orthic Black Chernozem; Rego Black Chernozem; Orthic Humic Gleysol	6 - 70	Well to Poorly	silty sand

HL.2.2000-27
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BEDROCK							
R1.1	Bedrock with extreme slopes or greater, consisting of sandstones and shales where the unit occurs east of the Livingstone Range, and limestone of the Livingstone Formation within the Livingstone range itself; minor veneers of colluvium may occur in portions of the unit	*Generally unvegetated.*	non-soil	45+	Very Rapidly	rubbly to blocky	rubbly to blocky
R1.2	Bedrock with strong to steep slopes, consisting of sandstones and shales where the unit occurs east of the Livingstone Range, and limestone of the Livingstone Formation within the Livingstone range itself; minor veneers of residuum and colluvium can be relatively common in portions of the unit	*Shrubs, lichens possible, some scattered conifer where there is suitable substrate.* Rough fescue/hairy wild rye - smooth brome // Bearberry/hairy wild rye (bSA)	non-soil; Orthic Regosol	16 - 45+	Very Rapidly to Rapidly	rubbly to blocky	rubbly to blocky

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VARIOUS VENEERS (COLLUVIUM-DOMINATED) OVER BEDROCK						
VR1.1	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; occurrence widespread in Sub-Alpine, restricted to northern aspects in Montane portions of the study area	*Closed coniferous forest, usually lodgepole pine-dominated, particularly in the Sub-Alpine, usually cover class D. Douglas-fir common in Montane.* False azalea/grouseberry (eSA); Canada buffaloberry/hairy wild rye (cMN); Creeping mahonia - white meadowsweet (dMN); Thimbleberry/pine grass (eMN)	Orthic Eutric Brunisol; Eluviated Eutric Brunisol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly silty cla sandy sandy sand
VR1.2	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units	*Closed to semi-open coniferous forest e.g. pine-Doug fir-spruce; much less pine at drier upper slopes of Montane; may have aspen inclusions at lower elevations.* False azalea/grouseberry (eSA); Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN)	Orthic Eutric Brunisol; Eluviated Eutric Brunisol; Orthic Regosol	6 - 100	Rapidly to Well	rubbly silty cla sandy sandy sand

AL.2.2000-27
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VR1.3	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; occurrence extensive in Sub-Alpine portions of the study area, usually in association with VR1.1	*Semi-open coniferous, can have aspen/deciduous shrub inclusions near valley bottoms.* False azalea/grouseberry (eSA); Bearberry/hairy wild rye (bSA); Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN); Canada buffaloberry/hairy wild rye transition - creeping mahonia/white meadowsweet (c/dMN)	Orthic Eutric Brunisol; Eluviated Eutric Brunisol; Orthic Regosol; Rego Dark Gray Chernozem	6 - 100	Rapidly to Well	rubbly silt loam to silty clay loam; rubbly sandy clay; loam; sandy loam to loamy sand	rubbly silt loam to silty clay loam; rubbly sandy clay; loam; sandy loam to loamy sand; rubbly
VR1.4	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; occurrence often in conjunction with VR1.1 and VR1.2 along slopes of southern aspect in Sub-Alpine, also can occur along north-south trending ridge tops in Montane portions of the study area	*Open coniferous; on N-S ridge tops, can be limber pine and Douglas-fir along exposed bedrock strata.* Limber pine/juniper (aMN); Bearberry (bMN); Bearberry/hairy wild rye (bSA)	Orthic Eutric Brunisol; Orthic Regosol	6 - 100	Rapidly to Well	rubbly silt loam to silty clay loam; rubbly sandy clay; loam; sandy loam to loamy sand	rubbly silt loam to silty clay loam; rubbly sandy clay; loam; sandy loam to loamy sand; rubbly

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VR1.5	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; often occurs in conjunction with VR1.6, wih occurrence extensive in Montane portions of the study area along much of north-south trending ridges, and on southern aspects of east-west trending ridges such as along the flanks of Whaleback Ridge; occurrence in Sub-Alpine generally limited to southern aspects of relatively small areal extent, with frequency of occurrence decreasing westward from Montane - Sub-Alpine	*Grassland.* Rough fescue/Parry oat grass - California oat grass; Rough fescue/Parry oat grass - California oat grass / Rough fescue/hairy wild rye - smooth brome; Rough fescue/hairy wild rye - smooth brome; Western porcupine grass and Columbia needle grass; Forb meadows; Low shrubland	Rego Black Chernozem; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Well	rubbly s silty cla sandy c sandy l sand

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VR1.6	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; often occurs in conjunction with VR1.5, with occurrence extensive in Montane portions of the study area along much of north-south trending ridges, and on southern aspects of east-west trending ridges such as along the flanks of Whaleback Ridge; occurrence in Sub-Alpine generally limited to southern aspects of relatively small areal extent, with frequency of occurrence decreasing westward from Montane - Sub-Alpine	*Ecological function essentially like a grassland; grassland with sparse coniferous e.g. limber pine in Montane.* Rough fescue/Parry oat grass - California oat grass; Forb meadows; Rough fescue/hairy wild rye - smooth brome; Western porcupine grass and Columbia needle grass; Limber pine/juniper (aMN); Bearberry (bMN); Bearberry/hairy wild rye (bSA); False azalea/grouseberry (eSA)	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Well	rubbly s silty clay sandy c sandy lo sand

AL.2.2000-27
c.2

VR1.7	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater	*Shrubs, some trees, wide variations in species and densities.* Rough fescue/Parry oat grass - California oat grass / Bearberry (bMN); Low shrubland; Canada buffaloberry/hairy wild rye (cMN); Rough fescue/hairy wild rye - smooth brome / Bearberry/hairy wild rye (bSA)	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Humic Regosol; Orthic Regosol; Orthic Eutric Brunisol	6 - 100	Rapidly to Well	rubbly s silty cla sandy c sandy l sand
VR1.8	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to	*Deciduous forest, some conifer occasionally within, may have shrub patches.* Thimbleberry/pine grass (eMN); Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN)	Orthic Black Chernozem; Eluviated Black Chernozem; Orthic Dark Gray Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly s silty cla sandy c sandy l sand

HL.2 2000-27
c.2

VR1.9	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; commonly occurs within transitional areas between Montane and Sub-Alpine	*Mixture of open to semi-open deciduous, conifers and shrubs as closed patches interspersed with small, south-facing grass slopes. A complex of all this.* Thimbleberry/pine grass (eMN); Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN); Canada buffaloberry/hairy wild rye transition - creeping mahonia/white meadowsweet (c/dMN); False azalea/grouseberry (eSA); Rough fescue/Parry oat grass - California oat grass; Western porcupine grass and Columbia needle grass	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Eluviated Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly s silty cla sandy c sandy l sand
VR1.10	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit	*Grassland/conifer patches/shrubs and forbs; moister than VR1.5.* Rough fescue/Parry oat grass - California oat grass; Low shrubland; Canada buffaloberry/hairy wild rye (cMN)	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly s silty cla sandy c sandy l sand

AL.2.2000-27
C.2

VR1.11	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater	*Mixed wood forest.* Canada buffaloberry/hairy wild rye transition - creeping mahonia - white meadowsweet (c/dMN)	Orthic Eutric Brunisol; Orthic Black Chernozem; Eluviated Black Chernozem; Orthic Dark Gray Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly silty cla sandy sandy sand
VR1.12	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to	*Grassland // deciduous trees. Can be like VR1.6 with deciduous and some conifer.* Rough fescue/Parry oat grass - California oat grass // Creeping mahonia/white meadowsweet (dMN); Rough fescue/Parry oat grass - California oat grass // Canada buffaloberry/hairy wild rye (cMN); Rough fescue/Parry oat grass - California oat grass // Bearberry (bMN); Western porcupine grass and Columbia	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Well	rubbly silty cla sandy sandy sand

AL.3.2000-27
c 2

VR1.13	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units immediately downslope; slopes generally strong or greater; occurrence most common along the northern half of Whaleback Ridge within the transition area between Montane and Sub-Alpine	*Unit is a complex of numerous VR1 units, with northern aspects displaying properties of VR1.1 and VR1.2 units, and southern aspects displaying properties of VR1.4, VR1.6 and VR1.5 units.* Limber pine/juniper (aMN); Creeping mahonia - white meadowsweet (dMN); Canada buffaloberry/hairy wild rye (cMN); Rough fescue/Parry oat grass - California oat grass	Rego Black Chernozem; Orthic Eutric Brunisol; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly s silty cla sandy c sandy l sand
VR1.14	Veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over	*Cutblocks.* Anthropogenic	Orthic Eutric Brunisol; Eluviated Eutric Brunisol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly s silty cla sandy c sandy l sand

AL.2.2000-27
C.2

VR2.1	Veneers of strong slopes or less, largely consisting of medium to coarse textured colluvium, over inclined bedrock; residual material often common, either at surface on crests in the Livingstone Range, or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the unit transitional to and adjacent to MR or M units if they occur immediately downslope; unit is relatively more moist and soils can be relatively deeper than steeper sloped VR1.5 or VR1.6 units	*Grassland. Shrub patches often if E-W aspect, occasional clumps of mostly deciduous trees. Reflects moister conditions than steeper sloped areas like VR1.5. In Sub-Alpine, on "flat-tops" in mountainous areas, scattered conifer can be found.* Rough fescue/Parry oat grass - California oat grass; Rough fescue/hairy wild rye - smooth brome; Low shrubland	Rego Black Chernozem; Orthic Black Chernozem; Humic Regosol; Orthic Regosol	6 - 30	Well to Moderately Well	rubbly si silty clay sandy cl sandy lo sand
VR2.2	Veneers of strong slopes or less, largely consisting of medium to coarse textured colluvium, over inclined bedrock; residual material often common, either at surface on crests in the Livingstone Range, or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; morainal material may comprise a greater portion of the veneer on lower slope portions of the	*Coniferous forest.* False azalea/grouseberry (eSA)	Orthic Eutric Brunisol; Eluviated Eutric Brunisol	6 - 30	Well to Moderately Well	rubbly si silty clay sandy cl sandy lo sand

HL.2.2001-27
c.2

VR3.1	Dissected veneers, largely consisting of medium to coarse textured colluvium, over inclined, ridged to rolling bedrock; residual material often common at ridge crests, either at surface or, at upper slope positions, as a thin veneer underlying a thin and rubbly colluvial veneer, both over bedrock; slopes generally strong or greater	*Coniferous forest.* False azalea/grouseberry (eSA)	Orthic Eutric Brunisol; Eluviated Eutric Brunisol; Orthic Regosol	6 - 100	Rapidly to Moderately Well	rubbly silty cla sandy sandy sand
WETLAND						
W1.1	Areas of hygric or greater moisture regime consisting of mineral materials and relatively shallow organic deposits; no open water areas evident throughout much of the year	*Mosses, sedges; some shrubs.* Sedge meadow; Willow shrubland	Rego Humic Gleysol	0 - 5	Poorly to Very Poorly	clay loa mesic
W1.2	Areas of hygric or greater moisture regimes consisting of mineral materials and relatively shallow organic deposits; no open water areas evident throughout much of the year	*Shrubs intergrading to mosses and sedges at center.* Willow shrubland; Sedge meadows	Rego Humic Gleysol	0 - 5	Poorly to Very Poorly	clay loa mesic
W2.1	Areas of subhydric and greater moisture regimes consisting of mineral materials and relatively shallow organic	*Emergents, mosses, woody margins at times.* Sedge meadow; Willow shrubland	Terric Humisol; Terric Mesisol	0 - 0.5	Very Poorly	fibric to

AL.2.2000-27
c.2

W2.2	Areas of subhydric and greater moisture regimes consisting of mineral materials and relatively shallow organic deposits; open water evident throughout much of the year during most years	*Shrubs dominant.* Willow shrubland	Terric Humisol; Terric Mesisol	0 - 0.5	Very Poorly	fibric to
RESIDUUM-DOMINATED VENEERS OVER BEDROCK						
XR1.1	Veneers of residual materials over inclined bedrock; residuum comprised of unconsolidated rubble as well as poorly consolidated, weathered sandstones, siltstones or mudstones; colluvium comprises a greater portion of the veneer at lower slope areas within the unit; occurrence generally on crest and upper slope positions within the Livingstone Range; also can occur at similar topographic positions on major ridges in the Montane (though often not mappable there)	*Open coniferous forest. May have shrubs on Whaleback Ridge in NE of study area.* Rough fescue/Parry oat grass - California oat grass / Limber pine/juniper (aMN); Rough fescue/Parry oat grass - California oat grass / Canada buffaloberry/hairy wild rye (cMN); Forb meadows / False azalea/grouseberry (eSA); Rough fescue/hairy wild rye - smooth brome / Bearberry/hairy wild rye (bSA)	Orthic Regosol; Orthic Eutric Brunisol	6 - 100+	Rapidly to Well	silty cla loam; ru
XR1.2	Veneers of residual materials over inclined bedrock; residuum comprised of unconsolidated rubble as well as poorly consolidated, weathered sandstones, siltstones or	*Grassland, sparse coniferous overstorey if present.* Rough fescue/Parry oat grass - California oat grass; Rough fescue/hairy wild rye - smooth	Orthic Regosol; Rego Black Chernozem; Orthic Eutric Brunisol	6 - 100+	Rapidly to Well	silty cla loam; ru

AL.2.2000-27
C 2

XR1.3	Veneers of residual materials over inclined bedrock; residuum comprised of unconsolidated rubble as well as poorly consolidated, weathered sandstones, siltstones or mudstones; colluvium comprises a greater portion of the veneer at lower slope areas within the unit; occurrence generally on crest and upper slope positions within the Livingstone Range, often on extreme slopes	*Closed coniferous forest patches with open areas.* Bearberry/hairy wild rye (bSA) / Rough fescue/hairy wild rye - smooth brome	Orthic Regosol; Orthic Eutric Brunisol	6 - 100+	Rapidly to Well	silty cla loam; r
XR2.1	Dissected veneers of residual materials over inclined bedrock; residuum comprised of unconsolidated rubble as well as poorly consolidated, weathered sandstones, siltstones or mudstones; colluvium comprises a greater portion of the veneer at lower slope areas within the unit; occurrence limited, generally on some crest and upper slope positions within the Livingstone Range and at similar topographic positions on major ridges in the Montane, such as at Chimney Rock	*Herbaceous vegetation.* Rough fescue/hairy wild rye - smooth brome; Rough fescue/Parry oat grass - California oat grass	Orthic Regosol	6 - 100+	Rapidly to Well	silty cla loam; r

AL.2.2000-27
c.2

XR2.2	Dissected veneers of residual materials over inclined bedrock; residuum comprised of unconsolidated rubble as well as poorly consolidated, weathered sandstones, siltstones or mudstones; colluvium comprises a greater portion of the veneer at lower slope areas within the unit; occurrence limited, generally on some crest and upper slope positions within the Livingstone Range and at similar topographic positions on major ridges in the Montane, such as at Chimney Rock	*Coniferous components with herbaceous vegetation.* Limber pine/juniper (aMN) // Rough fescue/Parry oat grass - California oat grass / Forb meadows; Bearberry/hairy wild rye (bSA) // Rough fescue/hairy wild rye - smooth brome; Canada buffaloberry/hairy wild rye (cMN) // Rough fescue/Parry oat grass - California oat grass	Orthic Regosol; Orthic Eutric Brunisol	6 - 100+	Rapidly to Well	silty clay loam; ru

AL.2.2000-27
c.2

WHALEBACK AREA ECOLOGICAL LAND CLASSIFICATION LEGEND – Part 2

ECOSITE	PERMEABILITY	depth to BEDROCK (cm.)	depth to IMPERM. LAYER (cm.)	depth to WATER TABLE (cm.)	SURFACE ROCKINESS CLASS	SURFACE STONINESS CLASS	SHRINK-SWELL POTENTIAL	POTENTIAL FROST ACTION	FLO HAZ
COLLUVIUM									
C1.1	Rapid	> 100	> 100	> 100	R0	S5	Low	Low	Nor
C1.2	Rapid to moderate	> 100	> 100	> 100	R0	S5	Low	Low	Nor
C1.3	Rapid to moderate	> 100	> 100	> 100	R0	S5	Low	Low	Nor
C2.1	Moderate	> 100	> 100	> 100	R0	S2	Variable[1]	Variable[1]	Nor
C2.2	Moderate	> 100	> 100	> 100	R0	S2	Variable	Variable	Nor
C3.1	Rapid to Moderate	0 - 100+	0 - 100+	> 100	R3	S4	Variable	Variable	Nor Rar
FLUVIAL									
F1.1	Slow to Rapid	> 100	> 100	> 40	R0	S4	Variable	Variable	Var
F2.1	Moderate	> 100	> 100	> 100	R0	S0	Moderate	High	May exp
F2.2	Moderate	> 100	> 100	> 100	R0	S0	Moderate	High	May exp
F2.3	Moderate	> 100	> 100	> 100	R0	S0	Moderate	High	May exp
F3.1	Moderate	> 100	> 100	> 100	R0	S0	High	High to	May

PL.2.2000-27
c.2

F4.3	Moderate	> 100	> 100	> 50	R0	S0	Low to Moderate	Low to Moderate	Rare
F4.4	Moderate	> 100	> 100	> 50	R0	S0	Low to Moderate	Low to Moderate	Rare
GLACIOFLUVIAL									
GF1.1	Moderate to Rapid	> 100	> 100	> 100	R0	S1	Variable	High	None Rare
GF1.2	Moderate to Rapid	> 100	> 100	> 100	R0	S1	Variable	High	None Rare
GF1.3	Slow to Moderate	> 100	> 100	> 75	R0	S1	Variable	High	May expe
GF2.1	Moderate	> 100	> 100	> 100	R0	S2	Variable	High	None Rare
GF2.2	Moderate	> 100	> 100	> 100	R0	S2	Variable	High	None Rare
GF3.1	Moderate to Rapid	> 100	> 100	> 100	R0	S3	Variable	Variable	None
GF3.2	Moderate to Rapid	> 100	> 100	> 100	R0	S3	Variable	Variable	None
GF4.1	Moderate to Rapid	> 100	> 100	> 100	R0	S2	Variable	High	None Rare
GLACIOLACUSTRINE									
GL1.1	Moderate	> 100	> 100	> 100	R0	S0	Variable	Variable	None
MORAINE									
M1.1	Moderate	> 100	> 100	> 100	R0	S1	Moderate to High	High	None
M1.2	Moderate	> 100	> 100	> 100	R0	S1	Moderate	High	None

AL.2 2000-27
c.2

M1.7	Moderate to Slow	> 100	> 100	> 100	R0	S1	Moderate to High	High	Non
M1.8	Slow to Moderate	> 100	> 100	> 75	R0	S1	Moderate to High	High	Non
M1.9	Moderate	> 100	> 100	> 100	R0	S1	Moderate to High	High	Non
MORAINAL VENEERS OVER BEDROCK									
MR1.1	Moderate	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.2	Moderate	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.3	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non Rare
MR1.4	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.5	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.6	Slow to Moderate	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.7	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.8	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR1.9	Moderate	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non
MR2.1	Moderate to Slow	> 40	> 40	> 100	R0	S1	Variable	Moderate to High	Non

PL 22W-27
c 2

VR1.3	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.4	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.5	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.6	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.7	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.8	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.9	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.10	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.11	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.12	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.13	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR1.14	Moderate to Rapid	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR2.1	Moderate	> 25	> 25	> 100	R2	S3	Variable	Variable	Non
VR2.2	Moderate	> 25	> 25	R2	> 100	S3	Variable	Variable	Non
VR3.1	Moderate to Rapid	> 25	> 25	> 100	R2	S4	Variable	Variable	Non
WETLAND									
W1.1	Slow	> 100	> 100	> 50	R0	S0	Moderate on mineral soil; Very High on	High	Freq

AL.2.2000-27
c.2

W2.2	Slow	> 100	> 100	0	R0	S0	Very High	High	Frec
RESIDUUM-DOMINATED VENEERS OVER BEDROCK									
XR1.1	Rapid to Moderate	> 25	> 25	> 100	R4	S4	Low	Low	Non
XR1.2	Rapid to Moderate	> 25	> 25	> 100	R4	S4	Low	Low	Non
XR1.3	Rapid to Moderate	> 25	> 25	> 100	R4	S4	Low	Low	Non
XR2.1	Rapid to Moderate	> 25	> 25	> 100	R4	S4	Low	Low	Non
XR2.2	Rapid to Moderate	> 25	> 25	> 100	R4	S4	Low	Low	Non

[1] A rating of "Variable" means that the rating spans three classes (e.g. Low to Moderate to High)

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